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ABSTRACT

This curriculum guide provides technology learning activities designed to prepare students in grades 6-10 to work in the world of the future. The 8-day course provides exploratory, hands-on learning activities and information that can enhance the education of students of all types in an integrated curriculum that provides practical applications of academic skills. The guide contains both instructor and student sections. The instructor's section includes the following: background information; expected learner outcomes; suggested activities; suggested resources; instructional sequence; equipment, tools, and supplies worksheet; pretest and posttest with answers; and an evaluation summary. The student's section contains the following components: an introduction; summary of activities; pretest and posttest instructions; assignments; goal; glossary; expected learner outcomes; objectives; related Technology Student Association events; academic and workplace applications; impact statements; career information; and an optional activity that could be used for solving problems or reinforcing learning. This guide curriculum contains activities for learning structural engineering, such as using various types of measuring devices, drawing bridge designs, building a bridge from wood sticks and testing its capacity, and writing an essay explaining bridge design. (KC)

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ED 380 603

Technology Learning Activity



Technology Education Series **STRUCTURAL ENGINEERING**

TLA TE-1102

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CIMC
Teacher Edition

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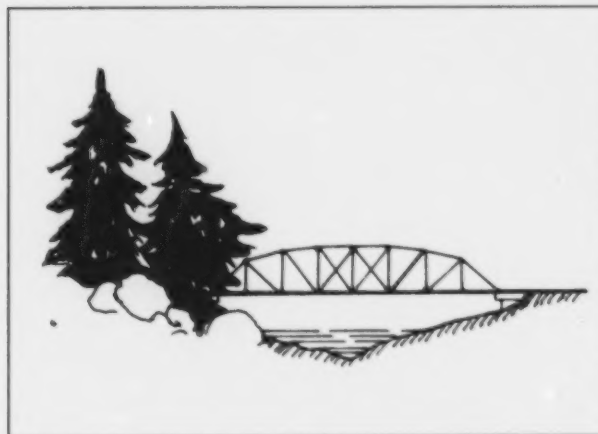
TECHNOLOGY EDUCATION

TECHNOLOGY LEARNING ACTIVITY

TE1102

STRUCTURAL ENGINEERING

Suggested Time: 8 Days



Developed by the
Curriculum and Instructional Materials Center
for the Technology Education Division
Oklahoma Department of Vocational and Technical Education

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FOREWORD

What will be the careers of the future? The workforce of tomorrow will be shaped by the technologies being developed today. Students today need accurate, interesting information on growing technologies in order to make informed decisions about their futures.

It is our hope that this curriculum will help improve the quality of career decisions for our students. Students are introduced to a wide range of current, "cutting-edge" technologies and are encouraged to think critically about how those technologies influence their lives and futures. Today's students do not have to become the victims of "technological illiteracy," but instead can learn to anticipate technological developments and take positive steps to prepare for the future.

Technology Learning Activities provide students with the knowledge and an introduction to the skills they need for a positive learning and career experience. Every generation is faced with learning how to manage technological advances. Information gained through participation in the *Technology Education* program can help students develop a holistic view of technology on which to base their educational and career decisions.

*Roy Peters, Jr., Ed.D., State Director
Oklahoma Department of
Vocational and Technical Education*

*Roger Stacy, Ed.D., State Supervisor
Technology Education
Oklahoma Department of
Vocational and Technical Education*

PREFACE

We believe that one of the most effective ways to improve education is through the development and implementation of a sound instructional materials system. Technology Education instructional materials represent a new design for CIMC which recognizes the importance of graphic materials in the learning process.

Technology Education instructional materials are designed for 6th through 10th grade students. The design of these materials is based on current research on how people read and gain information from documents. The design is called "New Look" and integrates both graphics and text into a balanced presentation which is easy to use and follow.

Technology Education provides the student a look at what the world will be like in the future based on technologies in use and being developed today. Throughout the Technology Education instructional materials, the students are introduced to "cutting-edge" technologies that they will use and encounter in a working environment later in life. This exposure gives them a wide range of experiences on which to base career decisions.

This publication is intended as a starting point, from which the teacher can innovate, localize, and personalize in order to prepare students for their future. The *Technology Education* series of Technology Learning Activities was written with the realization that we are creating the workforce of tomorrow by how and what we teach about technology today.

*Sherry Wietelman, Curriculum Development Specialist
Curriculum and Instructional Materials Center
Oklahoma Department of
Vocational and Technical Education*

*Charles F. Kemnitz, President
Atlal Communications, Inc.*

ACKNOWLEDGEMENTS

The Curriculum and Instructional Materials Center (CIMC) extends its appreciation to those individuals who played important roles in the development of Technology Learning Activity materials.

Generous thanks is extended to Lynn Hawkins and Jim Harder, both Technology Education teachers at Mayfield Junior High School, for the time, talent and knowledge they contributed in determining the content of this Technology Learning Activity (TLA). We also extend our thanks to them for writing the pilot TLA upon which this TLA was based.

Thank you is also extended to the vocational educators who helped with field testing and contributed their expert input on individualized vocational instructional methods.

Alan Fillmore
Meeker High School

Jerry Lewis
Atoka High School

Ron Givens
Tulsa-Nimitz Middle School

We also thank the State Director, Dr. Roy Peters, Jr., and the Assistant State Director, Dr. Charles O. Hopkins, for their continued support throughout this project.

The school administrators who supported instructor participation in this project and/or allowed their facilities to be used as field test sites in this project deserve a special thank you, as well.

Chris Gillespie
Atoka High School

Brent Walden
Meeker High School

Marolyn Hunnicutt
Tulsa-Nimitz Middle School

Joe Shirley
Mayfield Junior High School

Oklahoma Department of Vocational and Technical Education
Technology Education staff who provided leadership and direction on
this project also deserve special recognition.

Roger Stacy, Ed.D.
State Supervisor
Technology Education

Donovan Bowers
Assistant State Supervisor
Technology Education

Harold Holley
Assistant State Supervisor
Technology Education

Special Recognition and gratitude is expressed to Dr. Charles F. Kemnitz who trained and coordinated the efforts of a team of technical writers on this project. His professionalism, dedication and commitment to quality instructional materials allowed us to design learning activities that students can readily use to explore new and existing technologies.

Only through the close cooperation of the Curriculum and Instructional Materials Center staff was this curriculum developed. Sincere thanks are shared with the CIMC coordinators.

Brenda Stacy, Ed.D.
CIMC Coordinator

Lynna Ausburn, Ph.D.
CIMC Development Coordinator

Special recognition and thanks are also extended to other individuals within the Oklahoma Department of Vocational and Technical Education (ODVTE) involved in the development and distribution process: Noel Wilcoxson, Duane "Frosty" Foster and Diane Ensign and their staffs at the ODVTE Print Shop; Bob Davis and staff artist Kathryn Moore for the cover design; Darrel Stiles and his staff in the ODVTE Warehouse for packaging and coordinating transportation and distribution of these materials; and Rose Primeaux and her staff in Word Processing.

Finally, a big thank you to all ODVTE team members who offer their support on a daily basis in "behind-the-scenes" ways but never seem to be recognized for their contributions: Suzanne Perry and Terri Tomson, CIMC secretaries; Karen Heppel and Shirley Hill, Technology Education secretaries.

*Sherry Wietelman
Curriculum Development Specialist
Curriculum and Instructional Materials Center
Oklahoma Department of Vocational and Technical Education*

TECHNOLOGY EDUCATION OVERVIEW

About the Program

Because the American culture is distinctly characterized as technological, it becomes the function of our schools to give every student an insight into and an understanding of the technological nature of the culture. Technology Education strives to perform this function.

Technology Education in Oklahoma is an instructional program that provides young men and women (grades 6 - 10) with daily, hands-on exploratory experiences and insights into technology and career opportunities so that they can make meaningful occupational and educational choices. It is a program which can enhance the educational experience of all students, whether they are the valedictorian/honor-type student, the middle range/average student, or the student who has found little success in school, namely the at-risk student.

Technology Education acquaints all students with their technological environment so they can make rational decisions about their own lives on a day-to-day basis and participate in controlling their own destiny. The program directs students to related technological and industrial fields, enabling students to realize their full potential and make maximum use of their individual talents in fulfilling career goals in their selected areas of employment.

Technology education capitalizes on the individual's potential for reasoning and problem solving, for imagining and creating, and for constructing and expressing through the use of tools and materials related to technology. It develops content and

TECHNOLOGY EDUCATION OVERVIEW

experiences to contribute to the growth and development of students commensurate with their potential. Thus, Technology Education is a basic and fundamental study for all persons in regard to career explorations and educational opportunities.

Opportunities to develop and apply leadership, social, civic, and technologically related skills are provided through the Technology Student Association (TSA). TSA is the appropriate vocational student organization identified as a teaching tool for teachers to use in assisting students to achieve identified course competencies. Competency-based activities are an integral part of the instructional program.

All Technology Education courses are taught in a one-period block of time (45-55 minutes), with each of the four Technology systems (communication, construction, manufacturing, and transportation, energy and power) being designed to provide a means through which other courses such as math, science, English, and social studies can be applied in a practical manner within a technology-based situation. Teaching across the curriculum is vital to the success of a Technology Education program.

TECHNOLOGY EDUCATION OVERVIEW

About the TLAs

The *Technology Education* series consists of 40 Technology Learning Activities (TLAs) for instruction and a supplemental activities book. Each TLA is divided into two parts: an instructor's guide and a student guide. The instructor's guide provides an overview of Technology Education, a summary of activities and supplies needed for students to complete the Technology Learning Activity, a supplies and materials worksheet for the instructor, an overview of the particular TLA, written exam answer sheets, and evaluation summary for the TLA.

Master copies of the evaluation summary sheets, pretest and posttest, and supplies and materials worksheets are provided with this instructors edition of the TLA. These sheets may be reproduced for classroom use.

All of the TLAs focus on measurable and observable learning outcomes. Instructors are encouraged to supplement, personalize, localize, and motivate with these materials in order to develop a complete teaching/learning process.

TLAs are designed for use in more than one class period of instruction. Careful study of each TLA by the instructor will help her or him determine the following:

➤ Skills to demonstrate

TECHNOLOGY EDUCATION OVERVIEW

- Supplies and equipment needed
- Amount of time needed for student practice
- Workstation Bookshelf, Instructors Reference Materials, and a bibliography are provided for supplemental resources
- Supplementary materials, including print and non-print media to order
- Resource people to contact
- Facility modifications which may be necessary to administer the TLA

Each TLA is based on performance objectives. Performance objectives are specific, stating the performances necessary to meet the goal of the TLA.

The overall goal of the unit tells what the student should be able to do and what standard will be used to determine whether the student has achieved competency. The specific objectives outline the sequence of the competencies required to meet the TLA goal. The competencies may be either cognitive, requiring knowledge only, or psychomotor, requiring knowledge and skill.

TECHNOLOGY EDUCATION OVERVIEW

About Ordering TLAs

Additional TLAs in the *Technology Education* series may be ordered through the Oklahoma State Department of Vocational and Technical Education, Curriculum and Instructional Materials Center, 1500 West Seventh Avenue, Stillwater, OK 74074-4364. Phone 1-800-522-5810.

NOTE: The 1100- and 1200-series numbers given on the next page are for ordering TLA Instructor's Editions; to order Student Editions, change the first two numbers to 31 (for 8-Day TLAs) or 32 (for 6-Week TLAs).

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TLA Title	Order No.
8-DAY TLAs	
Aerospace and Flight	TE1117
Agricultural Education	TE1123
Audiovisual Programming	TE1131
CAD — Autocad Release 10	TE1114
Career Search	TE1104
Drafting	TE1134
Electricity — Principles and Applications	TE1105
Electronic Publishing	TE1135
Electronics (CES)	TE1106
Fluidics Technology	TE1116
Health Occupations	TE1124
Home Economics	TE1125
Introduction to VoTech	TE1122
Introduction to Animation	TE1132
Keyboarding and Computer Application	TE1115
Laser/Fiber Optics/Holography	TE1129
Lasers Technology	TE1103
Marketing Education	TE1126
Material Processes — Plastics	TE1133
NASA Aerospace-Spacelink	TE1111
Photography	TE1130
Problem Solving	TE1110
Research and Design	TE1101
Residential Construction	TE1121
Robotics — Control Technology	TE1112
Robotics — ProArm	TE1113
Safety	TE1107
Structural Engineering	TE1102
Synergetic Technology	TE1120
Technical Report Writing	TE1118
Technology Challenge	TE1109
Thermal Screen Printing	TE1119
Trade and Industrial Education	TE1127
TSA Leadership	TE1108
Vocational Business	TE1128
6-WEEK TLAs	
Animator	TE1203
CAD/Board Drafting	TE1201
Control Technology	TE1202
Electronics/Electricity/Robotics	TE1204
Electronic Publisher	TE1205

TECHNOLOGY EDUCATION OVERVIEW

Corrections and Suggestions

CIMC wants to provide Technology Education instructors and students materials that are accurate and effective. Although the CIMC strives to maintain the highest standards of development and production, oversights occasionally do occur. If you find any errors in this or other CIMC publications or have suggestions for improving their usefulness, please notify the CIMC staff. One easy way of pointing out errors is to make a photocopy of the affected page and indicate the correction on the copy. Mail this information to the CIMC, where it will be used to correct the publication before the materials are reprinted.

To ensure that the material is updated on a timely basis, notify the CIMC of necessary corrections as soon as possible. Do not assume that someone else will notice the error and inform the CIMC; other users may be making the same assumption. Please send corrections and recommendations for improving this publication to the following address:

*Curriculum Development Coordinator
Curriculum and Instructional Materials Center
Oklahoma Department of Vocational and
Technical Education
1500 West Seventh Avenue
Stillwater, Oklahoma 74074-4364*

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Background Information

Expected Learner Outcomes

INSTRUCTOR'S SECTION

The background information component provides instructors with basic information about the subject of the TLA. Instructors are encouraged to use suggested resources for additional information on the specific technology used in each TLA.

There are 19 Expected Learner Outcomes for the *Technology Education* series. Not every TLA fulfills all 19 Expected Learner Outcomes, so outcomes specific to each TLA are listed in the Instructors Section and in the Students Section. The 19 Expected Learner Outcomes for the *Technology Education* series are:

- ◆ The student will know and appreciate the importance of technology and technological literacy.
- ◆ The student will explore career opportunities so they can make meaningful occupational choices.
- ◆ The student will explore future educational opportunities so they can make meaningful educational choices.
- ◆ The student will apply problem solving and critical thinking techniques.
- ◆ The student will apply math, science, reading, and other school subjects in a practical situation.
- ◆ The student will develop keyboarding and computer literacy skills.

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INSTRUCTOR'S SECTION

- ◆ The student will develop basic skills in the safe and proper use of tools, machines, materials, processes, and technical concepts.
- ◆ The student will recognize and develop individual talents.
- ◆ The student will think logically and sequentially.
- ◆ The student will develop leadership, creative abilities, positive self-concepts, and individual potential in a technological society.
- ◆ The student will become a more sophisticated consumer of the goods and services of a technological society.
- ◆ The student will adjust to a changing technological environment.
- ◆ The student will develop an understanding and the ability to adapt to those technological forces that influence life in the 21st Century.
- ◆ The student will develop an understanding of economic development.
- ◆ The student will communicate by making clear and relevant points through the development of mental process skills.

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INSTRUCTOR'S SECTION

- ♦ The student will apply design, imagination, and creative abilities.
- ♦ The student will learn applications of lifelong learning skills.
- ♦ The student will think globally and act locally.
- ♦ The student will explore the organization and management systems of business and industry.

Suggested Activities

The suggested activities component is to assist during the preparation stage of the teaching/learning process. The activities provide suggestions for preparation and evaluation during the instructional process. The instructor should read the suggested activities before assigning the TLAs to allow time to obtain supplemental materials, prepare audiovisual materials, and contact outside resource persons. Duties of the instructor will vary according to the particular TLA.

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Suggested Resources

INSTRUCTOR'S SECTION

Suggested resources, include people, and print and non-print media that may be used with the TLA. References used during the development of each TLA are also provided. The instructor can use suggested resources and TLA references to supplement her or his knowledge of the subject to help students with particular interests or objectives in the area covered. Please note that suggested resources and references listed in this publication existed when this publication was written. CIMC assumes no responsibility for providing these materials and cannot ensure the availability of these materials as individual vendors, manufacturers, and publishers may discontinue these products at any time.

Instructional Sequence

This component provides instructors with daily lesson plans for the TLA. Included in the instructional sequence component are suggested daily assignments and equipment, tools, and supplies that will be needed for each student. A column for facility requirements or modifications is provided for each instructor. This component is provided as a guide to plan for and monitor students' progress through the TLA.

Equipment, Tools and Supplies: Summary Worksheet

This component is provided as a planning tool for instructors. It provides instructors with a list of the necessary equipment, tools and supplies to support student activities and provides specific information for budgeting purposes.

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Prefest and Posttest

INSTRUCTOR'S SECTION

These components provide criterion-referenced evaluation of the objectives listed in each TLA. If objectives or activities have been added, deleted, or modified, appropriate changes should be made on the tests.

Test Answers

This component is provided to assist instructors in evaluating student performance on written tests.

Evaluation Summary

This component is provided to assist instructors in summarizing the performance of each student on an individual basis. The evaluation summary forms are also provided as photocopy masters for the instructors use.

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Introduction

Summary of Activities

STUDENT'S SECTION

Daily activities are the step-by-step procedures students will follow to complete the learning experience. Each TLA is organized by daily tasks and activities. Students are able to pace their progress through the TLA by referring to the activities for the day.

Within the daily activity pages are components common to all TLAs.

A Summary of Activities page begins each day of the TLA. This page provides several important pieces of information for both the student and instructor.

- ①** In the left column this page provides the student with a list of activities to be accomplished that day.
- ②** In the right column the major Academic and Workplace Application which applies to that day's activities is graphically indicated with a standard icon.
- ③** Below the icon is a list of specific skills reinforced during that day's activities.

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Pretest Instructions

STUDENT'S SECTION

The students are required to take a Pretest as one of the first day's activities. The instructions for the Pretest are given in this section.

Assignments to Turn In

Day One includes a list of all assignments the students are expected to turn in during or at completion of the TLA. This list includes all tests, activities, and products covered in the TLA.

Goal

On Day One, following the assignments checklist, is a concise statement of the overall goal of the TLA. This statement summarizes the purpose for completing the TLA and encourages the student to think about the broader implications of the learning experience.

Words You Should Know

The first day's activities includes a glossary of unfamiliar technical terms used in the TLA. Often these terms are necessary for the student in order to accurately follow instructions in the activity procedures. The students should be encouraged to review this glossary and refer to it often during the course of the TLA.

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Expected Learner Outcomes Reinforced by this TLA

STUDENT'S SECTION

As stated in the guide to the Instructors Section, there are 19 identified Expected Learner Outcomes associated with the *Technology Education* series. This section of Day One activities lists the Expected Learner Outcomes that specifically apply to the TLA. A student who reviews this list will gain a better understanding of the scope of experiences and skills to be gained from the TLA.

Objectives

Each TLA is made up of a set of measurable objectives. In this section on Day One, students are given a list of all the objectives addressed in the TLA. This list can serve to introduce students to the "flow" of the TLA as they build introductory skills in a technology.

Related TSA Competitive Event(s)

Each TLA may be used by students to begin work toward completion of a Technology Student Association competitive event. Some TLAs are tied to a specific TSA event; other TLAs may be used with several events. This Day One section gives the student and instructor a list of appropriate TSA events which the TLA may support.

TSA competitive events promote leadership development, and an understanding that winning isn't everything but involvement is. Events are staged at Local, Regional, State, and National levels through which the student may progress.

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Academic and Workplace Applications

Preparing students to enter successfully into today's world ...

... emergence of a renewed emphasis on basic academic skills ...

STUDENT'S SECTION

The curricular content and activities found in this Technology Learning Activity help students apply academic and workplace competencies. These competencies include: Reading Skills, Writing Skills, Mathematics skills, Science Skills, Oral Communications Skills, Interpersonal or Relating Skills, Creative Thinking and Problem Solving Skills, Employability Skills, and Social Studies Skills.

Preparing students to enter successfully into today's world of work offers vocational education a substantial challenge. The contemporary workplace is characterized by constant and rapid technological change and by increasing job complexity and skill intensity. Due to rapid technological advancement, the half-life of work skills is now reduced to a bare three to five years. Out of this new workplace environment has arisen a growing national awareness of the critical importance of an American workforce armed with the skills necessary to survive in a competitive economy.

One result of this national awareness has been the emergence of a renewed emphasis on basic academic skills in all areas of education. Pressure to increase academic skill development is being placed on education by both legislative action and industry mandate. The Carl D. Perkins Vocational and Applied Technology Education Act of 1990 sets stringent academic and workplace skill requirements for vocational education. State legislatures are increasingly requiring basic skills accountability by teachers and school administrators.

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... expected learner outcomes are being implemented with increasing frequency.

The issue of basic skills ... was successfully addressed in a national three-year study ...

... research indicates clearly that American employers ... need a variety of skills ...

STUDENT'S SECTION

Graduation exams, minimum competency requirements, and expected learner outcomes are being implemented with increasing frequency. In addition, business and industry are delivering the message clearly to educators that vocational competence now requires increased strength in academic and workplace skills.

The issue of the basic skills currently required in the work place was very successfully addressed in a national three-year study conducted jointly by the American Society of Training and Development (ASTD) and the U.S. Department of Labor (DOL). The findings of this study were published in 1990 in the book, *Workplace Basics: The Essential Skills Employers Want*.

The ASTD/DOL research indicates clearly that American employers have discovered that their workforces need a variety of skills that include, but are not limited to, the classic academic trio of reading, writing, and computation. Employers now are also looking for competence in areas such as "learning to learn," problem solving and critical thinking, interpersonal and teamwork skills, oral communication and listening techniques, and the social and personal management skills that demonstrate a capacity for independence and responsibility in on-the-job performance.

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... business and industry have expanded and re-defined "workplace basics."

CIMC materials contain information and activities which develop academic and workplace application competencies ...

To assist teachers and students in identifying activities which promote academic and workplace skills ...

STUDENT'S SECTION

It is clear that the requirements of today's business and industry have expanded and re-defined "workplace basics." It is in line with this re-definition, and with the competency requirements of current education legislation, that the Oklahoma Department of Vocational and Technical Education has chosen to address "basic skills" in the instructional materials produced by its Curriculum and Instructional Materials Center.

It is not a new development for CIMC materials to contain information and activities which develop academic and workplace application competencies in students undertaking vocational programs. What is new is the specific marking, or flagging, of items in our instructional materials that address academic and workplace application skills.

To assist teachers and students in identifying activities which promote academic and workplace skills development, CIMC has implemented a marking system which uses simple graphic symbols, or icons. These icons are located in the right margins of Activity Sheets. The following is an explanation of the icons and the kinds of academic and workplace application activities they indicate.

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READING SKILLS:

Skills involving use of print resource material for

obtaining and applying information.



WRITING SKILLS:

Skills involving written communication of

processes, information, or ideas.



MATH-EMATICS SKILLS:

Skills involving computation

calculation, and interpretation of numerical data.

STUDENT'S SECTION

Current vocational education literature indicates that functional literacy as a workplace basic needs to be defined in terms of reading competencies actually required for job performance. The activities identified with this icon as addressing reading skills in CIMC materials deal specifically with developing reading skills in an applied, job-related context. These range from general information-gathering activities to tasks requiring use of specific technical reference materials. Many contain a "learning to learn" aspect, which promotes engaging actively and purposefully in vocationally relevant enquiry.

Tasks identified with this icon promote development of skills in written communications. As with reading skills, the writing skills emphasized in CIMC materials have a vocational context. They include filling out forms, keeping work activity records, writing simple memos and letters, generating more complex reports and articles, and written expression of ideas and concepts related to vocational performance or exploration.

This icon identifies activities which develop vocationally-related skills in computation, measurement and estimation, selection and application of appropriate mathematical processes, and collecting, displaying, or interpreting data.

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information or theory.

SCIENCE

SKILLS:

Skills involving mastery and application of scientific



and listening.

ORAL COMMUNICATION

SKILLS:

Skills involving speaking



working and getting along with others.

INTERPERSONAL OR RELATING

SKILLS:

Skills involving

STUDENT'S SECTION

This icon marks activities which are related to the development of skills in either the physical or biological sciences. These skills stress occupationally-related applications of science and technology.

Activities marked with this icon promote development of effective speaking and listening. They include practice in such areas as speaking techniques, word choice, non-verbal messages, use of communication media, and using active listening techniques. Many of these activities promote "learning to learn" skills in verbal enquiry.

Activities which deal directly with skills in relating to others are marked with this icon. This includes areas such as multi-cultural awareness, group processes and dynamics, negotiation, dealing with conflict, cooperation and teamwork, values and attitudes, and leadership and motivation.

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CREATIVE THINKING AND PROBLEM SOLVING SKILLS:

Skills

Involving comprehending, applying, analyzing, and developing complex ideas and situations.



EMPLOYABILITY SKILLS:

Skills

Involving choosing, obtaining, and succeeding in a career.



SOCIAL STUDIES SKILLS:

Skills

Involving investigation and application of social concepts.

STUDENT'S SECTION

This icon identifies activities which stress development of higher-order thought processes such as problem identification and analysis, lateral thinking, evaluating alternatives, developing solutions, examining assumptions, and evaluating outcomes.

Activities marked with this icon relate to competencies required to obtain employment and develop a career. These competencies include specific occupational tasks. They also include items such as career analysis and selection, job searching, completing applications and resumes, interviewing, and business etiquette and personal management skills required for job-keeping and maturing in one's work. Examples of the latter category include personal presentation, self-discipline, work accuracy, reliability, discretion, punctuality, stress handling, judgement, confidence, etc.

This icon marks activities which stress competencies in fields relating to human society and its distribution and relationships. This includes areas such as history, geography, government and politics, economics, psychology, sociology, demographics, current events, cross-cultural studies, consumer issues, environmental issues, and ethical concerns in science and technology.

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Impact Statements

STUDENT'S SECTION

There are five areas of human culture that each TLA impacts. These impact statements appear during Day Eight, after the student has gained some familiarity with the technology.

- ① **ENVIRONMENTAL IMPACT:** A statement introducing the student to the impact of the technology on the environment.
- ② **SOCIAL/CULTURAL IMPACT:** A statement concerning the impact of the technology on society and culture.
- ③ **ECONOMIC IMPACT:** A statement concerning the impact of the technology on the economy.
- ④ **POLITICAL IMPACT:** A statement concerning the impact of the technology on politics, laws, and regulations, and the impact of politics on the development of the technology.
- ⑤ **ERGONOMIC IMPACT:** A statement concerning the ergonomic implications of the technology. Ergonomics is the study of developing products and systems that meet peoples' needs.

USING THIS PUBLICATION

STUDENT'S SECTION

Impact Statements offer the student the opportunity to see beyond the activities in the Technology Learning Lab and glimpse the real-world applications of the technology.

Career Search

Also on Day Eight, the students are given the assignment of investigating several career opportunities related to the technology of the TLA. The investigation is done with *Career Search Abstracts*. A list of up to five related careers is given, followed by pages from *Career Search Abstracts* that detail the career qualifications and work environment. The student is required to choose two related careers, read the appropriate abstracts, then write a short essay about why that career may be appealing.

Posttest Instructions

The students are required to take a Posttest as one of the last day's activities. The instructions for the Posttest are given in this section. The score for the Posttest, compared to the score for the Pretest may be compared to help determine the student's gain during the TLA.

USING THIS PUBLICATION

Skunk Works

STUDENT'S SECTION

Skunk Works, a Day Eight optional activity, include instructions that could be used for solving problems or reinforcing the enrichment of learning.

The term Skunk Works was coined by engineers at 3M Corporation in the mid-1960s. Some engineers wanted to develop a new product, but company management would not give them the time or money to work on the project. So the engineers "borrowed" time and money from approved projects to work on their "Skunk Works." When they finished developing the product, they presented it to management and it has been a 3M product ever since. The product: Velcro fasteners.

HAZARD ALERT MESSAGES

The Daily Activities include hazard alert information specific to the Activity. These messages should be discussed carefully and thoroughly. The Hazard Alert Message system used in the TLA is based on the American National Standards Institute (ANSI) Standard Z535, which provides for five levels of alert.

Students are introduced to the ANSI Hazard Alert Message system as an activity in the Safety TLA (TE1107/TE3107). This system was adopted by ANSI as the standard in 1990 and will be the hazard alert system in use when students reach the workplace.

Hazard Alert Messages in the TLA are indicated both by the color red and graphically. There are three types of hazard alert graphics used in the TLA:



Hazard Alert
Symbol

This Hazard Alert Symbol is used with the words DANGER, WARNING, and CAUTION. ANSI defines these words as:

DANGER indicates an imminently hazardous situation which, if not avoided, will result in death or serious injury.

WARNING indicates a potentially hazardous situation which, if not avoided, could result in death or serious injury.

CAUTION indicates a hazardous situation which, if not avoided, may result in minor or moderate injury.

HAZARD ALERT MESSAGES



Injury Hazard
Graphic



Avoidance
Graphic

There are two types of graphics used in conjunction with the hazard alert symbol. This type of graphic depicts a specific injury that may be expected if the hazard described in the alert is not avoided.

This second type of graphic is called an avoidance graphic. It depicts an action the student should take in order to avoid injury.

There are two other ANSI words used in the TLAs and the students should understand their meanings:

NOTICE indicates an action that could result in damage to property or equipment.

IMPORTANT indicates an instruction that can help the student do a better job.

TECHNOLOGY EDUCATION

STRUCTURAL ENGINEERING

TE1102/TE3102

INSTRUCTOR'S SECTION



BACKGROUND INFORMATION

The Structural Engineering TLA introduces students to construction technology. By designing and building a simple truss bridge, they will learn concepts such as building to specifications, evaluating different design options, and testing the final product.

Students who have completed the Problem Solving TLA should be encouraged to use the Problem Solving System in designing and building their model bridge.

The Structural Engineering TLA is also a TSA Competitive Event. Students who wish to should be encouraged to rebuild their bridge designs to enter TSA competitions.

INSTRUCTOR'S SECTION

EXPECTED LEARNER OUTCOMES

1. The student will know and appreciate the importance of technology and technological literacy.
2. The student will explore career opportunities so you can make meaningful occupational choices.
3. The student will apply problem-solving and critical thinking techniques.
4. The student will apply math, science, reading, and other school subjects in a practical situation.
5. The student will develop basic skills in the safe and proper use of tools, machines, materials, processes, and technical concepts.
6. The student will recognize and develop individual talents.
7. The student will think logically and sequentially.

INSTRUCTOR'S SECTION

EXPECTED LEARNER OUTCOMES

**EXPECTED LEARNER
OUTCOMES**

8. The student will become a more sophisticated consumer of the goods and services of a technological society.
9. The student will adjust to a changing technological environment.
10. The student will develop an understanding and the ability to adapt to those technological forces that influence life in the 21st Century.
11. The student will apply design, imagination, and creative abilities.
12. The student will think globally and act locally.

**INSTRUCTOR'S
SECTION**

**EXPECTED LEARNER
OUTCOMES
(Continued)**

SUGGESTED ACTIVITIES

- ✓ Obtain materials to supplement unit.

NOTE: See Suggested Resources. Review instructional outline for this TLA. Modify time frames to suit class needs and plan activities for each class period.

- ✓ Study the specific objectives to determine those you will cover in your presentation. Decide also which objectives should be taught to which students.
- ✓ Determine scope and sequence of objectives that you add. Design and develop support materials, including evaluation techniques, for additional objectives.
- ✓ Determine how you will schedule time for students to demonstrate competence in the required procedures.

INSTRUCTOR'S SECTION

PREPARATION

SUGGESTED RESOURCES

De Old, Alan R., et al. *Transportation: The Technology of Moving People and Products*, Worcester, MA: Davis Publications Inc., 1986.

Horton, Andrew, et al. *Exploring Construction Systems*, Worcester, MA: Davis Publications, inc., 1991.

Huth, Mark. *Construction Technology*, Albany, NY: Delmar Publishers, Inc., 1989.

INSTRUCTOR'S SECTION

INSTRUCTOR'S REFERENCE MATERIALS

LESSON PLAN

INSTRUCTOR'S SECTION

Instructional Sequence	Technology Education: Structural Engineering		
	Assignments	Equipment, Tools, and Supplies	Facilities Requirements/ Modifications
Day 1	Complete Pretest Read and study the Assignments to Turn In: Goal Objectives, Student Learner Outcomes, Implications, Academic and Workplace Applications, and Information Sheets.	Computer score card sheet or notebook paper #2 pencil	
Day 2	Complete Objective 1: Read markings on a standard 12" ruler and identify by matching to the correct measurement. Complete Objective 2: Using a standard 12" ruler, measure lines and identify by matching to the correct measurements.	12" ruler Computer score card sheet #2 pencil	
Day 3	Complete Objective 3: Given examples of different types of truss bridges, create rough designs of at least two truss bridges and select one to build. Complete Objective 4: Draw a refined design, to specifications, of the selected design.	Paper: 8.5 x 11, 3 sheets Pencil	

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LESSON PLAN

INSTRUCTOR'S SECTION

Instructional Sequence	Technology Education: Structural Engineering		
	Assignments	Equipment, Tools, and Supplies	Facilities Requirements/ Modifications
Day 4	Begin Objective 5. Using the materials provided, build the selected bridge.	Bridge design Pine or balsa wood strips, 1/8 X 1/8 X 24", 10 Hot glue gun 1 stick hot glue Waxed paper Cutting tool Cutting surface	
Day 5	Complete Objective 5.	(see Day 4)	
Day 6	Complete Objective 6. Perform a stress test on the bridge by applying weight until it breaks.	Completed bridge Tables, 2 Yardstick or tape measure 5 gallon buckets, 2 Sand Cup or scoop Testing hook Scale Paper, 8.5 x 11, 1 Pencil	
Day 7	Write a one page essay describing the process of designing, building, and testing the bridge, giving the bridge's efficiency rating.	Paper, 8.5 X 11, 1 Pen or pencil	

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Instructional Sequence	Technology Education: Structural Engineering		
	Assignments	Equipment, Tools, and Supplies	Facilities Requirements/ Modifications
Day 8	Complete any incomplete assignments Read Impact Statements Complete Career Search Activity and Post test Complete (1) Problem Solver if all other work has been completed	Computer score card sheet #2 pencil For Problem Solver Paper, 8.5 X 11", 1 Pencil	

Equipment, Tools, and Supplies:
Summary Worksheet

Equipment, Tools, and Supplies	Per Student	Per Period	Total Needed	Special Considerations	Cost per Student	Cost per Period	Total Cost	Special Considerations
Table	2							
Hot glue gun	1							
Wood strips, 1/8 X 1/8 X 24"	10							
Hot glue stick	1							
Waxed paper	1							
Cutting tool	1							
Cutting surface	1							
5-gallon bucket	2							
Sand	5 lb							
Scale	1							
Testing hook	1							
Computer score card sheet	1							
#2 pencil	1							
Paper, 8 1/2 X 11"	6							
12" ruler	1							
Cup or scoop	1							
Yardstick or measuring tape	1							

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PRETEST

1. The Golden Gate Bridge is an example of a:
 - a) Arch bridge
 - b) Beam bridge
 - c) Suspension bridge
 - d) Truss bridge

2. Reinforced concrete is often damaged by:
 - a) Grass
 - b) Bird droppings
 - c) Road salt
 - d) Pollution

3. The earliest bridges were:
 - a) Arch bridges
 - b) Beam bridges
 - c) Suspension bridges
 - d) Truss bridges

INSTRUCTOR'S SECTION

PRETEST PART 1

PRETEST

INSTRUCTOR'S SECTION

4. Most road bridges built today are:

- a) Arch bridges
- b) Beam bridges
- c) Suspension bridges
- d) Truss bridges

5. The longest bridges are usually:

- a) Arch bridges
- b) Beam bridges
- c) Suspension bridges
- d) Truss bridges

6. Steel bridges are always stronger than concrete bridges.

- a) True
- b) False

7. Many bridges are still built of wood today.

- a) True
- b) False

PRETEST PART 2

PRETEST

8. Cables in suspension bridges are generally made of steel.
- a) True
 - b) False
9. A truss bridge is a variation of a beam bridge.
- a) True
 - b) False
10. Early truss bridges were made of vines.
- a) True
 - b) False

Spaces 11-25 are used for Objective 1 quizzes on using a ruler.

INSTRUCTOR'S SECTION

PRETEST PART 3

POSTTEST

INSTRUCTOR'S SECTION

POSTTEST PART 1

26. The Golden Gate Bridge is an example of a(n):
- a) Arch bridge
 - b) Beam bridge
 - c) Suspension bridge
 - d) Truss bridge
27. Reinforced concrete is often damaged by:
- a) Grass
 - b) Bird droppings
 - c) Road salt
 - d) Pollution
28. The earliest bridges were:
- a) Arch bridges
 - b) Beam bridges
 - c) Suspension bridges
 - d) Truss bridges

POSTTEST

INSTRUCTOR'S SECTION

29. Most road bridges built today are:

- a) Arch bridges
- b) Beam bridges
- c) Suspension bridges
- d) Truss bridges

30. The longest bridges are usually:

- a) Arch bridges
- b) Beam bridges
- c) Suspension bridges
- d) Truss bridges

31. Steel bridges are always stronger than concrete bridges.

- a) True
- b) False

32. Many bridges are still built of wood today.

- a) True
- b) False

33. Cables in suspension bridges are generally made of steel.

- a) True
- b) False

POSTTEST PART 2

POSTTEST

INSTRUCTOR'S SECTION

34. A truss bridge is a variation of a beam bridge.
- a) True
 - b) False
35. Early truss bridges were made of vines.
- a) True
 - b) False

POSTTEST PART 3

POSTTEST

(a) correct (b) incorrect

- 36. Truss
- 37. Suspenshen
- 38. Efficiency
- 39. Construction
- 40. Reinforcement

INSTRUCTOR'S SECTION

SPELLING TEST

TEST ANSWERS

- 1. C
- 2. C
- 3. B
- 4. A
- 5. C
- 6. B
- 7. B
- 8. A
- 9. A
- 10. B

- 11. B
- 12. C
- 13. C
- 14. A
- 15. B
- 16. A
- 17. B
- 18. D
- 19. D
- 20. C
- 21. B
- 22. B
- 23. C
- 24. B
- 25. A

INSTRUCTOR'S SECTION

PRETEST ANSWERS

OBJECTIVE 1 ANSWERS

**TEST
ANSWERS**

- 26. C
- 27. C
- 28. B
- 29. A
- 30. C
- 31. B
- 32. B
- 33. A
- 34. A
- 35. B
- 36. A
- 37. B
- 38. B
- 39. A
- 40. A

**INSTRUCTOR'S
SECTION**

POSTTEST ANSWERS

EVALUATION SUMMARY

INSTRUCTOR'S SECTION

5 POINTS EACH

Objective 2: Using a standard 12" ruler, measure lines and identify by matching to the correct measurement. _____

Objective 3: Given examples of different types of truss bridges, create rough designs of at least two truss bridges and select one to build. _____

10 POINTS EACH

Pretest _____

Career Search Activity _____

Objective 1: Read markings on a standard 12" ruler and identify the correct measurement by matching. _____

Objective 4: Draw a refined design, to specifications, of the selected rough design. _____

Objective 6: Perform a stress test on the bridge by applying weight until it breaks. _____

Objective 7: Use data from the stress test and a given formula to calculate the efficiency of the bridge. _____

1. PROCESS EVALUATION

EVALUATION SUMMARY

Objective 8: Write a one-page essay, using correct spelling and grammar, describing the process of designing, building, and testing the bridge, and giving the bridge's efficiency rating. _____

20 POINTS EACH

Objective 5: Using the materials provided, build the selected bridge. _____

INSTRUCTOR'S SECTION

1. PROCESS EVALUATION (Continued)

1. PROCESS
EVALUATION
SCORE _____

EVALUATION SUMMARY

The instructor is encouraged to individualize the TLA to address the specific needs of each student, considering age and ability level. In addition to the specific areas on the chart on the next page, the instructor should take into account the student's desire, enthusiasm, etc.

Evaluation based upon observed performance = 40 possible points

EVALUATION RATING TABLE

Student Name: _____

Criteria	Points Possible	Points Earned
Design Appearance	10	_____
Neatness	5	_____
Point-to-point Contact	10	_____
Craftsmanship	10	_____
Performance under stress test	5	_____

INSTRUCTOR'S SECTION

2. PRODUCT EVALUATION

2. PRODUCT
EVALUATION
SCORE _____

EVALUATION SUMMARY

Use the conversion table below to convert
Product Evaluation scores to percentiles.

40 = 100%
39 = 97.5
38 = 95
37 = 92.5
36 = 90

35 = 87.5
34 = 85
33 = 82.5
32 = 80

31 = 77.5
30 = 75
29 = 72.5
28 = 70

27 = 67.5
26 = 65
25 = 62.5
24 = 60

INSTRUCTOR'S SECTION

2. PRODUCT EVALUATION (Continued)

CONVERSION TABLE

EVALUATION SUMMARY

Posttest score _____

INSTRUCTOR'S SECTION

3. WRITTEN EVALUATION



3. WRITTEN
EVALUATION
SCORE _____

EVALUATION WORKSHEET

1. Process evaluation score _____
2. Product evaluation score _____
3. Written evaluation score _____
4. Total score _____

Divide Total Score by 3

Total score for TLA =

$$1 + 2 + 3 = 4$$

Total score /3 = Score

TLA Score _____

BIBLIOGRAPHY

De Old, Alan R., et al. *Transportation: The Technology of Moving People and Products*, Worcester, MA: Davis Publications Inc., 1986.

Horton, Andrew, et al. *Exploring Construction Systems*, Worcester, MA: Davis Publications, inc., 1991.

Huth, Mark. *Construction Technology*, Albany, NY: Delmar Publishers, Inc., 1989.

INSTRUCTOR'S SECTION

TECHNOLOGY EDUCATION

TECHNOLOGY

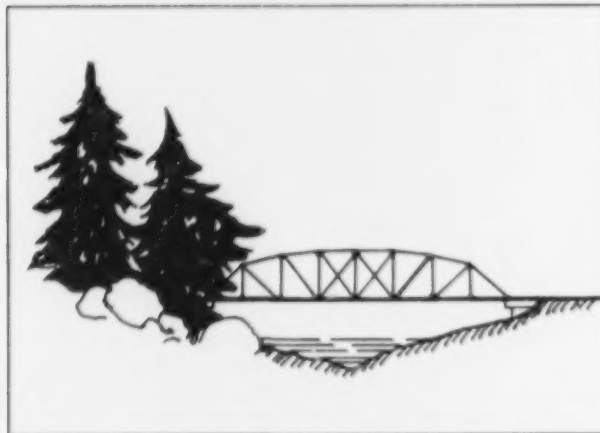
LEARNING

ACTIVITY

TE3102

STRUCTURAL ENGINEERING

Suggested Time: 8 Days



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Oklahoma Department of Vocational and Technical Education

92-006518

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TECHNOLOGY EDUCATION STRUCTURAL ENGINEERING

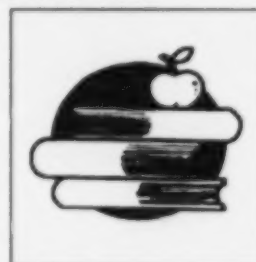
DAY 1 ACTIVITIES



On Day 1 you should complete the following activities:

- ① Complete Pretest
- ② Read Assignments to Turn In (items to complete in 8 days)
- ③ Read Goal
- ④ Read Words You Should Know
- ⑤ Read Expected Learner Outcomes
- ⑥ Read Objectives
- ⑦ Read Related TSA Competitive Events
- ⑧ Read Academic and Workplace Applications
- ⑨ Read Information Sheets

SUMMARY OF ACTIVITIES



Reading Comprehension Skills:

- ◆ Gain factual information
- ◆ Make generalizations

Functional Reading Skills:

- ◆ Follow written instructions
- ◆ Interpret graphics and symbols
- ◆ Use content area vocabulary

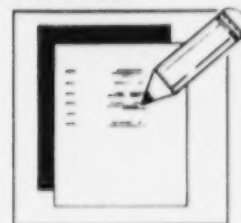
TECHNOLOGY EDUCATION STRUCTURAL ENGINEERING

DAY 1 ACTIVITIES



PRETEST

DIRECTIONS



You will need a computer scan sheet or card to record your answers to the following Pretest. Be sure to write your name, the title of the TLA, the date, and the class period on the computer scan sheet or card using a #2 pencil. Use rows 1-10 to record the answers to the Pretest. If your answers will be hand-scored, use a blank sheet of notebook paper to record your answers and number your answers 1-10.

Get Pretest Questions from your instructor.

TECHNOLOGY EDUCATION STRUCTURAL ENGINEERING

DAY 1 ACTIVITIES



ASSIGNMENTS TO TURN IN

At the end of 8 days, you should give the following items to your instructor for evaluation:

1. Computer score card/sheet, with answers to:
 - a) Pretest
 - b) Answers to Day 1 Activities - Using a Ruler
 - b) Posttest (including spelling test)
2. Career Search Activity
 - a) Two occupations identified
 - b) Explanation of why those occupations appealed to you
3. Bridge Designs — at least two rough bridge designs

TECHNOLOGY EDUCATION STRUCTURAL ENGINEERING

DAY 1 ACTIVITIES



4. **Refined Bridge Design, including:**

- a) Top view
- b) Side view
- c) Dimensions

5. **Bridge Model**

Because the model will be destroyed during testing, it must be evaluated by the instructor before the end of the TLA

6. **Essay describing the process of designing and building your bridge and giving the bridge's efficiency rating**

TECHNOLOGY EDUCATION STRUCTURAL ENGINEERING

DAY 1 ACTIVITIES



The Bridge Building TLA will introduce you to construction technology. You will apply the same general concepts in designing and building your bridge that construction engineers use when designing and building bridges for public use.

GOAL

TECHNOLOGY EDUCATION STRUCTURAL ENGINEERING

DAY 1 ACTIVITIES



Arch bridge — a bridge design that uses arches for support.

Beam bridge — a bridge that is supported at or near its ends.

Efficiency (of a bridge) — a measure of the performance of a bridge design equal to the failure weight divided by the weight of the bridge.

Failure weight — the weight at which the supports of a bridge fail.

Suspension bridge — bridges supported by long cables and tiers.

Truss — a frame of beams that can be used for support in bridges.

WORDS YOU SHOULD KNOW

TECHNOLOGY EDUCATION STRUCTURAL ENGINEERING

DAY 1 ACTIVITIES



EXPECTED LEARNER OUTCOMES

- You will know and appreciate the importance of technology and technological literacy.
- You will explore career opportunities so you can make meaningful occupational choices.
- You will apply problem-solving and critical thinking techniques.
- You will apply math, science, reading, and other school subjects in a practical situation.
- You will develop basic skills in the safe and proper use of tools, machines, materials, processes, and technical concepts.
- You will recognize and develop individual talents.
- You will think logically and sequentially.

TECHNOLOGY EDUCATION STRUCTURAL ENGINEERING

DAY 1 ACTIVITIES



EXPECTED LEARNER OUTCOMES (Continued)

- You will become a more sophisticated consumer of the goods and services of a technological society.
- You will adjust to a changing technological environment.
- You will develop an understanding and the ability to adapt to those technological forces that influence life in the 21st Century.
- You will apply design, imagination, and creative abilities.
- You will think globally and act locally.

TECHNOLOGY EDUCATION STRUCTURAL ENGINEERING

DAY 1 ACTIVITIES



At the completion of this Technology Learning Activity, the student should be able to:

OBJECTIVES

1. Read markings on a standard 12" ruler and identify the correct measurement by matching.
2. Using a standard 12" ruler, measure lines to the nearest 1/4" and identify the correct measurement by matching.
3. Given examples of different types of truss bridges, create rough designs of at least two truss bridges and select one to build.
4. Draw a refined design, to specifications, of the selected rough design.
5. Using the materials provided, build the selected bridge.
6. Perform a stress test on the bridge by applying weight until it breaks.
7. Use data from the stress test and a given formula to calculate the efficiency of the bridge.
8. Write a one-page essay describing the process of designing, building, and testing the bridge, and giving the bridge's efficiency rating.

TECHNOLOGY EDUCATION STRUCTURAL ENGINEERING

DAY 1 ACTIVITIES



The following TSA Competitive Events apply to your study of structural engineering:

- Engineering I and II
- Technical Report Writing
- Research Paper
- Extemporaneous Speech
- Prepared Speech

See *TSA Competitive Event Guidelines* for specific details on the competitions.

RELATED TSA COMPETITIVE EVENTS

TECHNOLOGY EDUCATION STRUCTURAL ENGINEERING

DAY 1 ACTIVITIES



The symbols in the right column are used to identify the Academic and Workplace Applications that are reinforced by specific activities in this TLA.

Even though each of the nine Academic and Workplace Application areas is applicable to Technology Education and the content of this TLA, the following competencies are specifically reinforced:

Language Arts Concepts Applied:

Reading Comprehension Skills:

- ◆ Gain factual information
- ◆ Make generalizations

Functional Reading Skills:

- ◆ Follow written instructions
- ◆ Interpret graphics and symbols
- ◆ Use content area vocabulary

Writing Concepts Applied:

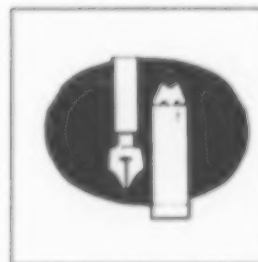
Language Skills:

- ◆ Use standard grammar
- ◆ Use correct spelling
- ◆ Use correct punctuation
- ◆ Use correct capitalization

Composition Skills:

- ◆ Use complete sentences

ACADEMIC AND WORKPLACE APPLICATIONS



TECHNOLOGY EDUCATION STRUCTURAL ENGINEERING

DAY 1 ACTIVITIES



Mathematics Concepts Applied:

Operation and Calculation Skills:

- ◆ Solve formulae and equations
- ◆ Calculate with decimals

Math Application Skills:

- ◆ Select/apply mathematical formulae

Functional Math Skills:

- ◆ Make measurements



Creative Thinking and Problem Solving Concepts Applied:

- ◆ Evaluate alternatives
- ◆ Select an alternative
- ◆ Create a finished product
- ◆ Evaluate results/outcomes



TECHNOLOGY EDUCATION STRUCTURAL ENGINEERING

DAY 1 ACTIVITIES



INFORMATION SHEETS

BRIDGE TYPES

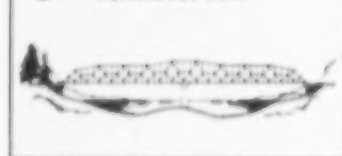
The first bridge ever constructed was probably a tree thrown across a small stream. The bridge allowed people to cross the stream without getting wet. This is an example of a primitive **beam bridge** — a bridge that gets its support at or near the ends. Later, these early engineers realized that it was even easier to cross the stream when several trees were joined together as a bridge. This realization led to the development of the **truss bridge**, a variation of the beam bridge. A **simple truss bridge** (see first figure to the right) exerts downward pressure on both ends. For longer spans, a **continuous truss bridge** (see second figure to the right) has extra supports. Many of the older highway bridges are truss bridges.

Another common type of bridge is the **arch bridge** (see figure to the right). Arch bridges are often used for longer spans than beam or truss bridges. Today, most road bridges constructed are arch bridges.

A. Simple truss



B. Continuous truss



C. Arch



TECHNOLOGY EDUCATION STRUCTURAL ENGINEERING

DAY 1 ACTIVITIES



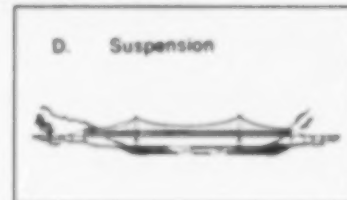
The longest bridges in the world are **suspension bridges** (see figure to the right). These bridges are supported by long cables, usually of steel, that are in turn supported by piers on the river bed. Suspension bridges were probably first used in Asia, where there are many plants that produce long, strong vines. Simple suspension bridges of twisted vines are still used in some areas of Asia. The longest bridge in the world, the Humber Suspension Bridge in Britain, is a suspension bridge. A famous American suspension bridge is the Golden Gate Bridge.

The first bridges were made of natural materials that were common to the areas where they were built, such as logs, stones, and vines.

The development of steel and concrete had a major effect on bridge building. The first all-steel bridge was built over the Missouri river in 1879. Over the next hundred years, steel and iron eliminated the use of wood in most bridges. Steel cables became popular in the 1930s, making vast suspension bridges possible.

In the 1960s, bridges built from pre-cast concrete block segments became common. These types of bridges are very economical and as strong as steel for small spans.

BRIDGE TYPES



BRIDGE MATERIALS

TECHNOLOGY EDUCATION STRUCTURAL ENGINEERING

DAY 1 ACTIVITIES



Reinforced concrete, which contains a steel mesh reinforcement, is used for many bridges today. However, it does not hold up well in areas that get heavy snowfall. When road salt is used on these bridges, the salt can destroy the steel reinforcements.

Some engineers are going back to the early days of bridge building and using wood as a construction material. Wooden bridges can last 50 to 100 years, which is approximately the same lifespan as a reinforced concrete bridge exposed to road salt. However, using wood in modern bridges is still considered a slightly radical idea.

BRIDGE MATERIALS

TECHNOLOGY EDUCATION STRUCTURAL ENGINEERING

DAY 1 ACTIVITIES

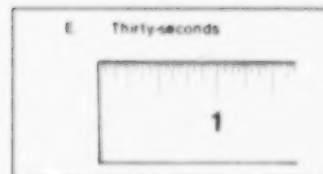
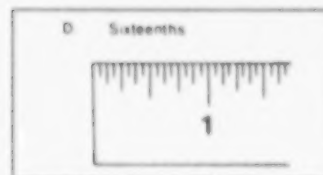
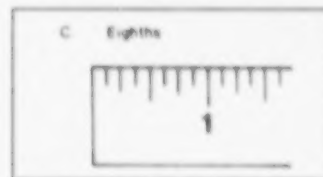
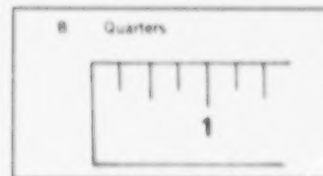
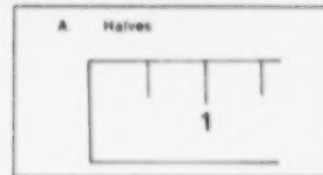


For the activities in this TLA you will need to know how to measure accurately with a 12" ruler. The figures to the right show the different measurements on a standard ruler.

Looking at each example, you can see that the smaller the increment of measurement, the smaller the line. Notice how the lines move up from $1/32"$ to $1"$.

— continued —

USING A RULER



TECHNOLOGY EDUCATION STRUCTURAL ENGINEERING

DAY 1 ACTIVITIES



Often measurements are not exact. For example, you may be given instructions to measure something "to the nearest inch." This means that your answer should be in whole inches. When you are given this kind of specification, your measurement may not be exact. It could be as far off as one-half of the unit of measure. In this example, if the object you measured was $3 \frac{1}{4}$ ", and you were asked to give the answer to the nearest inch, your answer would be 3". If you had said 4", you would be more than one-half the unit of measurement wrong (in this case, $\frac{1}{2}$ "). This is known as a **margin of error**. If you are asked to measure an object to the nearest $\frac{1}{2}$ ", your margin of error would be $\frac{1}{4}$ ". This means you could be $\frac{1}{4}$ " off the exact measurement and still be correct. The margin of error is always one-half of the unit of measure.

USING A RULER

TECHNOLOGY EDUCATION STRUCTURAL ENGINEERING

DAY 2 ACTIVITIES



On Day 2 you should complete the following activities:

- ① Reading standard ruler markings
- ② Measuring lines with a 12" ruler

SUMMARY OF ACTIVITIES



Functional Math Skills:
◆ Make measurements

TECHNOLOGY EDUCATION STRUCTURAL ENGINEERING

DAY 2 ACTIVITIES



Read markings on a standard 12" ruler and identify the correct measurement by matching.

In this activity, you will be asked to identify various ruler markings. Your measurements must be exact — there is no margin of error.

You will need a computer scan sheet or card to record your answers to the following questions. Be sure to write your name, the title of the TLA, the date, and the class period on the computer scan sheet or card using a #2 pencil. Use rows 11-15 to record the answers to this exercise. If your answers will be hand-scored, use a blank sheet of notebook paper to record your answers and number your answers 11-15.

For questions 11 - 15, use the ruler in the right column.

11. The measurement from 0 to A is:

- a) $\frac{1}{8}$ "
- b) $\frac{1}{4}$ "
- c) $\frac{1}{16}$ "
- d) $\frac{3}{4}$ "

12. The measurement from 0 to B is:

- a) $\frac{1}{4}$ "
- b) $\frac{3}{8}$ "
- c) $\frac{3}{4}$ "
- d) 1"

OBJECTIVE 1

INTRODUCTION

DIRECTIONS



TECHNOLOGY EDUCATION STRUCTURAL ENGINEERING

DAY 2 ACTIVITIES



13. The measurement from 0 to C is:

- a) 1"
- b) $1 \frac{1}{8}$ "
- c) $1 \frac{1}{2}$ "
- d) $\frac{1}{2}$ "

14. The measurement from 0 to D is:

- a) 2"
- b) $\frac{1}{2}$ "
- c) $2 \frac{1}{2}$ "
- d) $1 \frac{3}{4}$ "

15. The measurement from 0 to E is:

- a) $2 \frac{1}{8}$ "
- b) $2 \frac{1}{2}$ "
- c) $1 \frac{1}{2}$ "
- d) $2 \frac{3}{4}$ "



TECHNOLOGY EDUCATION STRUCTURAL ENGINEERING

DAY 2 ACTIVITIES



You will need a computer scan sheet or card to record your answers to the following questions. Be sure to write your name, the title of the TLA, the date, and the class period on the computer scan sheet or card using a #2 pencil. Use rows 16-20 to record the answers to this exercise. If your answers will be hand-scored, use a blank sheet of notebook paper to record your answers and number your answers 16-20.

For questions 16 - 20, use the ruler in the right column.

DIRECTIONS



16. The measurement from 0 to A is:

- a) $3/8"$
- b) $3/4"$
- c) $3/16"$
- d) $1/2"$

17. The measurement from 0 to B is:

- a) $8/16"$
- b) $3/4"$
- c) $3/8"$
- d) $1/2"$

18. The measurement from 0 to C is:

- a) $1"$
- b) $1 1/4"$
- c) $1 1/16"$
- d) $1 1/8"$

TECHNOLOGY EDUCATION STRUCTURAL ENGINEERING

DAY 2 ACTIVITIES



19. The measurement from 0 to D is:

- a) $1 \frac{1}{2}''$
- b) $1 \frac{5}{16}''$
- c) $1 \frac{3}{8}''$
- d) $1 \frac{5}{8}''$



20. The measurement from 0 to E is:

- a) $2 \frac{1}{16}''$
- b) $2 \frac{1}{8}''$
- c) $2 \frac{1}{4}''$
- d) $2 \frac{2}{16}''$

IMPORTANT: Continue Day 2
Activities by completing Objective
2.

TECHNOLOGY EDUCATION STRUCTURAL ENGINEERING

DAY 2 ACTIVITIES



Using a standard 12" ruler, measure lines to the nearest $\frac{1}{4}$ " and identify by matching to the correct measurement.

In this activity you will be given five lines to measure using a standard 12" ruler. Your measurement must be to the nearest $\frac{1}{4}$ ". This means your margin of error is $\frac{1}{8}$ ".

- 12" ruler
- Computer score sheet/card
- #2 pencil

A. _____

21. To the nearest $\frac{1}{4}$ ", how long is line A?

- a) $\frac{3}{4}$ "
- b) 1"
- c) $1\frac{1}{4}$ "
- d) $1\frac{1}{2}$ "

B. _____

22. To the nearest $\frac{1}{4}$ ", how long is line B?

- a) $1\frac{1}{8}$ "
- b) $1\frac{1}{2}$ "
- c) $1\frac{3}{4}$ "
- d) $1\frac{5}{8}$ "

OBJECTIVE 2

INTRODUCTION

TOOLS AND EQUIPMENT



TECHNOLOGY EDUCATION STRUCTURAL ENGINEERING

DAY 2 ACTIVITIES



C. _____

23. To the nearest $\frac{1}{4}$ ", how long is line C?

- a) $\frac{3}{8}$ "
- b) $\frac{1}{2}$ "
- c) $\frac{3}{4}$ "
- d) $\frac{7}{8}$ "

D. _____

24. To the nearest $\frac{1}{4}$ ", how long is line D?

- a) $\frac{1}{4}$ "
- b) $\frac{1}{2}$ "
- c) $\frac{3}{4}$ "
- d) $\frac{7}{8}$ "

E. _____

25. To the nearest $\frac{1}{4}$ ", how long is line E?

- a) $\frac{1}{4}$ "
- b) $\frac{1}{2}$ "
- c) $\frac{5}{8}$ "
- d) $\frac{3}{4}$ "

When you finish, clean work area and return tools and materials to their proper storage areas.

If you complete Day 2 Activities with time left over, you may begin Day 3 Activities.

TECHNOLOGY EDUCATION STRUCTURAL ENGINEERING

DAY 3 ACTIVITIES



On Day 3 you should complete the following activities:

- ① Create rough sketches for at least two truss bridges and select one to build.
- ② Draw a final design of the truss bridge you will build.

SUMMARY OF ACTIVITIES



Functional Math Skills:
♦ Make measurements

TECHNOLOGY EDUCATION STRUCTURAL ENGINEERING

DAY 3 ACTIVITIES



Given examples of different types of truss bridges, create rough designs of at least two truss bridges and select one to build.

In this activity draw rough sketches of at least two possible designs for a truss bridge and select one bridge to build.

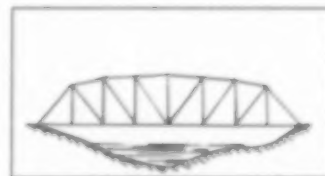
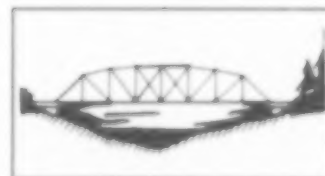
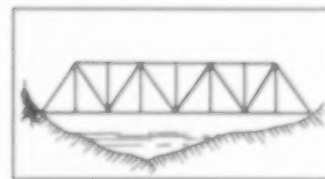
The figures in the right column show some examples of truss bridges. Use these to get ideas for your own design. Your bridge must meet the following specifications:

- The span (length from riverbank to riverbank) must be at least 14 inches.
- The width must be at least 1 1/2 inches.

Notice that these are minimum specifications. Your bridge cannot be smaller than these measurements. However, it can be larger.

OBJECTIVE 3

INTRODUCTION



TECHNOLOGY EDUCATION STRUCTURAL ENGINEERING

DAY 3 ACTIVITIES



➤ Ruler

➤ 3 pieces 8.5" X 11" paper

➤ Pencil

TOOLS AND MATERIALS

FOLLOW THESE STEPS:

STEP 1: Using the examples for ideas as needed, draw at least two rough sketches of possible bridge designs.

STEP 2: Select one of the bridge designs to be built.

IMPORTANT: Continue Day 3 Activities by Completing Objective 4.

TECHNOLOGY EDUCATION STRUCTURAL ENGINEERING

DAY 3 ACTIVITIES



Draw a refined design, to specifications, of the selected rough design.

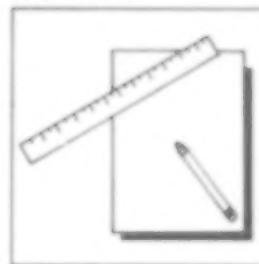
For this activity you will take the rough design you selected and draw a finished design. Your design should include a top and side view, as well as measurements for span and width.

- Paper (8.5" x 11")
- Pencil
- Ruler

OBJECTIVE 4

INTRODUCTION

TOOLS AND MATERIALS



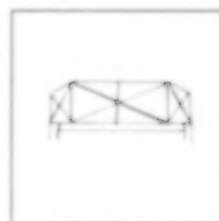
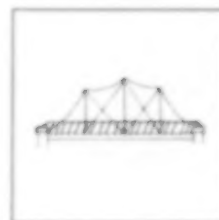
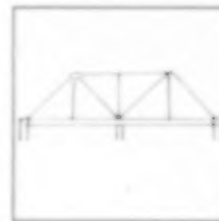
TECHNOLOGY EDUCATION STRUCTURAL ENGINEERING

DAY 3 ACTIVITIES

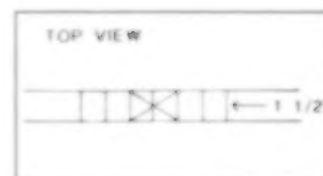
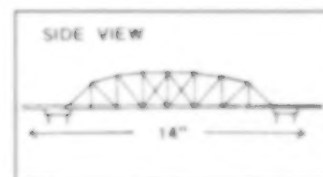


FOLLOW THESE STEPS:

STEP 1: Using your rough design, draw a refined design of your bridge, including views from the side and the top.



STEP 2: Mark the dimensions of the span on the side view and the bridge width on the top view.



TECHNOLOGY EDUCATION STRUCTURAL ENGINEERING

DAY 3 ACTIVITIES



FOLLOW THESE STEPS:

- STEP 3:** When you finish, clean work area and return tools and materials to their proper storage areas.



If you complete Day 3 Activities with time left over, you may begin Day 4 Activities.

TECHNOLOGY EDUCATION STRUCTURAL ENGINEERING

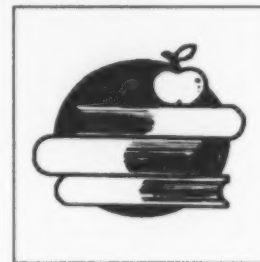
DAY 4 ACTIVITIES



On Day 4 you should complete the following activities:

- ① Cut the wood strips for the bridge
- ② Begin gluing wood strips together

SUMMARY OF ACTIVITIES



Functional Reading Skills:

- ◆ Follow written instructions

TECHNOLOGY EDUCATION STRUCTURAL ENGINEERING

DAY 4 ACTIVITIES



Using the materials provided, build the selected bridge.

Today you will begin building the bridge you selected from your two rough designs. You will start by cutting wood strips for the bridge.

- Paper (8.5" x 11")
- Pencil
- 10 pine wood strips, 1/8" X 1/8"
- Hot glue gun
- One stick hot glue
- Cutting surface
- Cutting tool
- 12" ruler
- Waxed paper

OBJECTIVE 5

INTRODUCTION

TOOLS AND MATERIALS



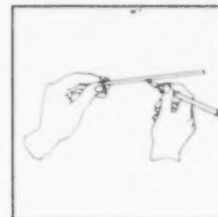
TECHNOLOGY EDUCATION STRUCTURAL ENGINEERING

DAY 4 ACTIVITIES



FOLLOW THESE STEPS:

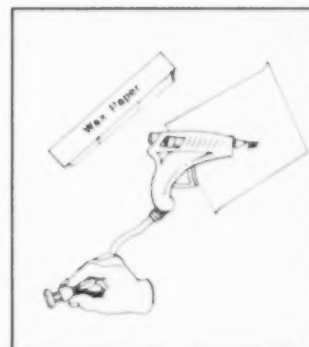
STEP 1: Use the cutting tool to cut the wood strips for your bridge design on the cutting surface.



CAUTION!
SEVERE CUT POSSIBLE. Knife blade is very sharp. FOLLOW SAFETY RULES.



STEP 2: Cover your work surface with the waxed paper and plug in the hot glue gun.



CAUTION!
BURN POSSIBLE. Glue is very hot. DO NOT TOUCH HOT GLUE.



TECHNOLOGY EDUCATION STRUCTURAL ENGINEERING

DAY 4 ACTIVITIES



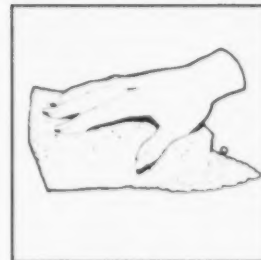
FOLLOW THESE STEPS:

STEP 3: Begin to assemble the bridge according to your design. Use the hot glue to hold the strips of wood together. Do not use too much glue — a little goes a long way.



STEP 4: When you run out of time for the day, put your bridge in a safe place to dry.

STEP 5: When you finish, clean work area and return tools and materials to their proper storage areas.



If you complete Day 4 Activities with time left over, you may begin Day 5 Activities.

TECHNOLOGY EDUCATION STRUCTURAL ENGINEERING

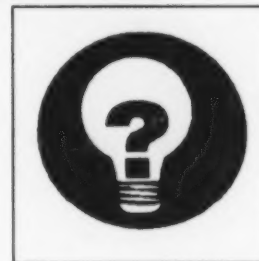
DAY 5 ACTIVITIES



On Day 5 you should complete the following activities:

- 1 Finish gluing wood strips together to build the bridge.

SUMMARY OF ACTIVITIES



♦ Create a finished product

TECHNOLOGY EDUCATION STRUCTURAL ENGINEERING

Using the materials provided, build the selected bridge.

Today you will finish building the bridge you selected from your two rough designs.

- Paper
- Pencil
- 10 pine wood strips, 1/8 X 1/8 X 24"
- Hot glue gun
- One stick hot glue
- Cutting surface
- Cutting tool
- 12" ruler
- Waxed paper

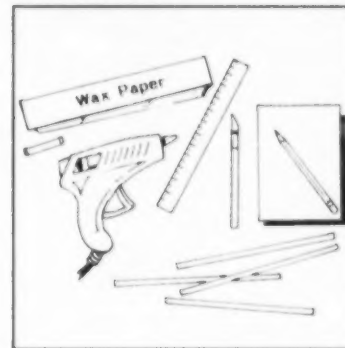
DAY 5 ACTIVITIES



OBJECTIVE 5

INTRODUCTION

TOOLS AND MATERIALS



TECHNOLOGY EDUCATION STRUCTURAL ENGINEERING

DAY 5 ACTIVITIES



FOLLOW THESE STEPS:

- STEP 1:** Finish gluing wood strips together to build the bridge you designed.

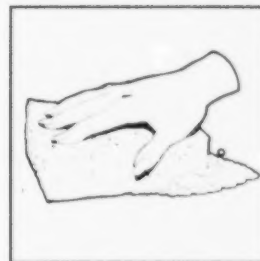


CAUTION!
BURN POSSIBLE. Glue is very hot.
DO NOT TOUCH HOT GLUE.



- STEP 2:** When the bridge is completed, ask your instructor to evaluate it before testing, then put it away in a safe place to dry.

- STEP 3:** When you finish, clean work area and return tools and materials to their proper storage areas.



TECHNOLOGY EDUCATION STRUCTURAL ENGINEERING

DAY 5 ACTIVITIES



If you complete Day 5 Activities with time left over, DO NOT begin Day 6 Activities. The bridge must dry overnight before it can be tested.

TECHNOLOGY EDUCATION STRUCTURAL ENGINEERING

DAY 6 ACTIVITIES



On Day 6 you should complete the following activities:

- ① Evaluate your bridge by performing a stress test.
- ② Use data from the stress test to calculate the efficiency of the bridge.

SUMMARY OF ACTIVITIES



♦ Evaluate results/outcomes

TECHNOLOGY EDUCATION STRUCTURAL ENGINEERING

DAY 6 ACTIVITIES



Perform a stress test on the bridge by applying weight until it breaks.

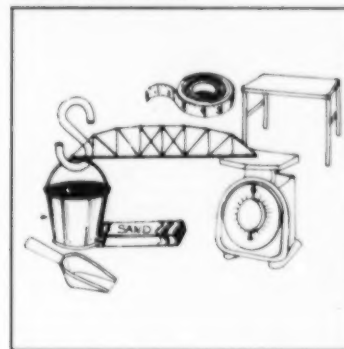
In this activity you will test the strength of the bridge you built. The stress test consists of putting a heavy weight on the bridge and determining the bridge's breaking point.

- Completed bridge
- 2 tables
- 5-gallon bucket of sand
- Empty 5 gallon bucket
- Cup or scoop
- Scales
- Testing hook
- Yardstick or measuring tape
- Pencil
- Paper

OBJECTIVE 6

INTRODUCTION

TOOLS AND MATERIALS



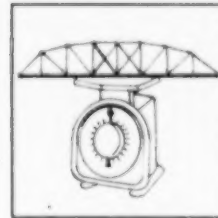
TECHNOLOGY EDUCATION STRUCTURAL ENGINEERING

DAY 6 ACTIVITIES

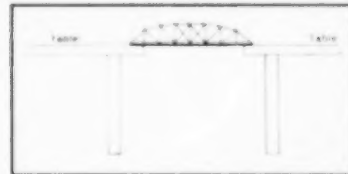


FOLLOW THESE STEPS:

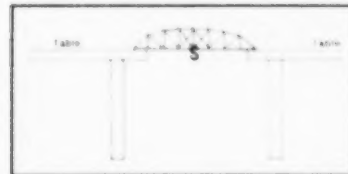
STEP 1: Weigh the bridge and record its weight in grams.



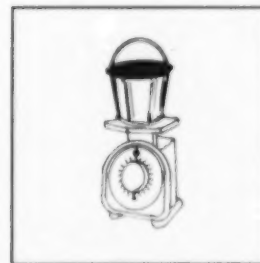
STEP 2: Set the two tables 14" apart using the yardstick or measuring tape. Place the bridge between the two tables.



STEP 3: Place the test hook in the middle of the bridge.



STEP 4: Place the empty 5-gallon bucket on the scale and set the scale to zero.



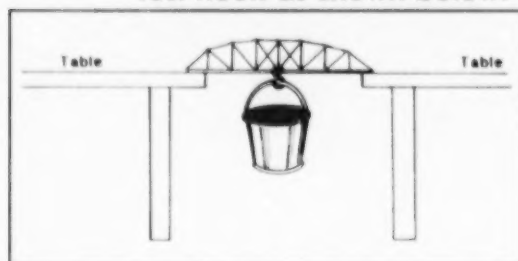
TECHNOLOGY EDUCATION STRUCTURAL ENGINEERING

DAY 6 ACTIVITIES

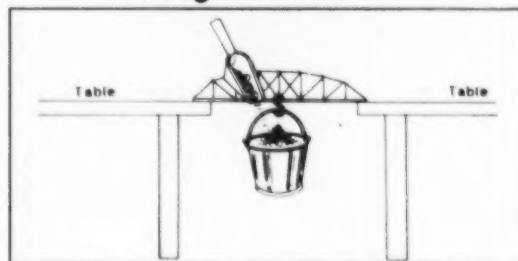


FOLLOW THESE STEPS:

STEP 5: Hook the empty 5-gallon bucket to the bottom of the test hook as shown below.



STEP 6: Using the cup or scoop, slowly pour sand into the empty bucket (see below) until the bridge breaks.



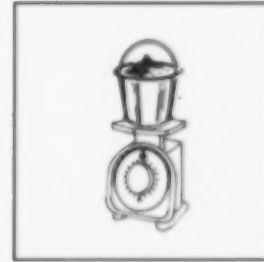
TECHNOLOGY EDUCATION STRUCTURAL ENGINEERING

DAY 6 ACTIVITIES



FOLLOW THESE STEPS:

- STEP 7:** Remove the bucket from the test hook and weigh it on the scales. Record the weight of the sand in pounds. Multiply this by 4.45 to get the failure weight.



IMPORTANT: Continue Day 6 Activities by completing Objective 7.

TECHNOLOGY EDUCATION STRUCTURAL ENGINEERING

DAY 6 ACTIVITIES



Use data from the stress test and a given formula to calculate the efficiency of the bridge.

For this activity you will use the failure weight of the bridge and the total weight of materials used in construction to calculate the bridge's efficiency.

FOLLOW THESE STEPS:

STEP 1: Take the total weight of your bridge and divide this by the failure weight. This is the efficiency rating.

Efficiency = $\frac{\text{Failure weight}}{\text{Weight of structure (grams)}}$

STEP 2: Ask your instructor to evaluate your bridge using TSA competitive event guidelines.

STEP 3: When you finish, clean work area and return tools and materials to their proper storage areas.

If you complete Day 6 Activities with time left over, you may begin Day 7 Activities.

OBJECTIVE 7

INTRODUCTION

TECHNOLOGY EDUCATION STRUCTURAL ENGINEERING

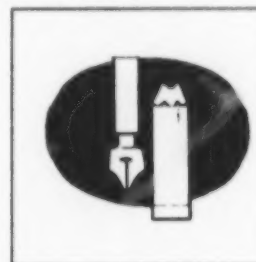
On Day 7 you should complete the following activities:

- 1 Write a short essay describing the process of designing, building, and testing your bridge.

DAY 7 ACTIVITIES



SUMMARY OF ACTIVITIES



Language Skills:

- ◆ Use correct grammar
- ◆ Use correct spelling
- ◆ Use correct punctuation
- ◆ Use correct capitalization

Composition Skills:

- ◆ Use complete sentences

TECHNOLOGY EDUCATION STRUCTURAL ENGINEERING

DAY 7 ACTIVITIES



Write a one-page essay, using correct grammar and spelling, describing the process of designing, building, and testing your bridge, and giving the bridge's efficiency rating.

For this activity you will describe what you have done in this TLA. Write the paper for someone who does not know anything about the Structural Engineering TLA. Discuss the methods you used to design the bridge. Was your design easier or more difficult to build than you thought it would be? Did you have to make any changes while building it? Give your bridge's efficiency rating, and describe what happened when you tested the bridge.

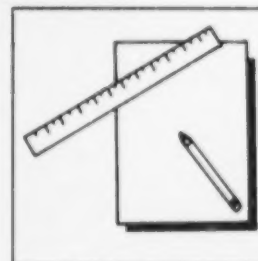
➤ 1 sheet paper

➤ Pen or pencil

OBJECTIVE 8

INTRODUCTION

TOOLS AND MATERIALS



TECHNOLOGY EDUCATION STRUCTURAL ENGINEERING

DAY 7 ACTIVITIES



FOLLOW THESE STEPS:

- STEP 1:** Write a one-page essay, using correct grammar and spelling, discussing what you did in the Bridge Building TLA. Be sure to give the bridge's efficiency rating.
- STEP 2:** When you finish, clean work area and return tools and materials to their proper storage areas.

If you complete Day 7 Activities with time left over, you may begin Day 8 Activities.

TECHNOLOGY EDUCATION STRUCTURAL ENGINEERING

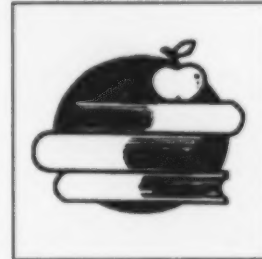
DAY 8 ACTIVITIES



On Day 8 you should complete the following activities:

- ① Complete any unfinished assignments.
- ② Read Impact Statements
- ③ Complete Career Search Activity
- ④ Complete the Post-test.
- ⑤ Turn in all assignments for the TLA.

SUMMARY OF ACTIVITIES



Reading Comprehension Skills:

- ♦ Gain factual information
- ♦ Make generalizations

Functional Reading Skills:

- ♦ Follow written instructions
- ♦ Interpret graphics and symbols
- ♦ Use content area vocabulary

TECHNOLOGY EDUCATION STRUCTURAL ENGINEERING

DAY 8 ACTIVITIES



Bridges began as man's way of manipulating his environment. A simple log thrown over a stream could let man conquer his environment by crossing the stream without getting wet.

Today, environmental concerns play a major part in bridge design. For example, the Golden Gate Bridge in San Francisco had to be designed to withstand the forces of salt, ice, and even earthquakes.

A new element in bridge design is that of using bridges instead of roads to lessen the environmental impact. An example of this is the award-winning Linn Cove Viaduct, part of the scenic Blue Ridge Parkway through the Appalachian Mountains. This bridge is actually an elevated road. Because the road was built above the terrain, the natural beauty of the land did not have to be destroyed.

ENVIRONMENTAL IMPACT



TECHNOLOGY EDUCATION STRUCTURAL ENGINEERING

Because of bridges, people can live, visit, and work in places they might not have been able to reach otherwise. Bridges allow people to travel easily to areas that once might have been practically or totally inaccessible. For example, in Florida, you can drive from Miami to Key West in three hours. If not for the bridges spanning between the Florida Keys, you would have to take a slow boat or expensive airplane to reach Key West.

All kinds of highway construction are expensive, and bridges are no exception. Engineers must strike a balance between the cost of the materials and labor and the necessary requirements for a safe bridge. By trying to cut expenses, an engineer could design an unsafe bridge.

Bridges must also be maintained. Often, a bridge on a rural road will be closed because it is unsafe and there are no funds available to repair or replace it.

DAY 8 ACTIVITIES



SOCIAL IMPACT



ECONOMIC IMPACT



TECHNOLOGY EDUCATION STRUCTURAL ENGINEERING

There are many political implications involved in building a bridge. The funds used are usually public funds from taxes. Land must be acquired from the original owners. If they do not want to sell their land, the state can invoke its right to **eminent domain**, which allows it to seize private land for public use and pay the owner a price it determines is fair. As you can imagine, this causes many legal battles.

Finally, for a large and impressive bridge, there may be a battle over which politician to name the bridge after.

Ergonomics means developing products and systems that are comfortable for people to use and that really fit their needs. One bridge may have to be designed to fit the needs of many different people. For example, a **bascule bridge** (often seen in movies during a car chase) allows boats to pass underneath by parting in the middle and swinging the two sections up and out of the way.

Even less spectacular bridges must be designed for the comfort and safety of any potential user. For example, the lanes must be wide enough for cars to cross safely.

DAY 8 ACTIVITIES



POLITICAL IMPACT



ERGONOMIC IMPACT



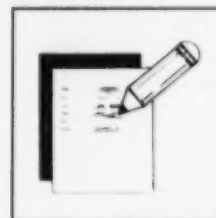
TECHNOLOGY EDUCATION STRUCTURAL ENGINEERING

DAY 8 ACTIVITIES



CAREER SEARCH ACTIVITY

DIRECTIONS



Using Career Search Abstracts, find the occupations listed below. Read the information about each. Select the two occupations that sound most appealing to you. On a separate sheet of paper, list the two occupations you selected and tell why. Remember to write using complete sentences, proper grammar, and correct spelling. Give the sheets to your instructor.

- Civil Engineer
- Industrial Engineer
- Construction Inspector
- Construction Laborer
- Cost Estimator

RELATED CAREERS

STRUCTURAL ENGINEERING CAREER SEARCH ABSTRACTS

DAY 8 ACTIVITIES



CIVIL ENGINEER

Nature of the Occupation

Civil engineers plan, design, and supervise the construction and maintenance of structures and facilities using new and established techniques and engineering principles.

Duties may include but are not limited to the following:

- Preparing plans and specifications
- Estimating costs and requirements of projects
- Testing materials to be used
- Determining solutions to problems
- Supervising construction and maintenance
- Inspecting existing or newly constructed projects and recommending repairs
- Performing technical research
- Determining the impact of construction on the environment

Occupation Specialties

(Dot codes in parenthesis)

Transportation Engineers (005.061-038) design and prepare plans, estimates, and specifications for the construction and operation of surface transportation projects according to state or federal construction policy.

Structural Engineers (005.061-034) plan, design, and oversee the erection of steel and other structural materials in buildings, bridges and other structures.

Hydraulic Engineers (005.061-018) design and direct the construction of power and other hydraulic engineering projects for the control and use of water.

Sanitary Engineers (005.061-030) design and oversee the construction and operation of hygienic projects.



Environmental Engineers (005.061-014) apply a knowledge of engineering by correcting or improving various areas of environmental concern, such as air, soil, or water pollution.

Working Conditions

Civil engineers may work alone or with other engineers, surveyors, or supervisors.

Civil engineers generally work 35 to 55 hours a week. They may work at construction sites or in clean, well-lighted and ventilated offices and research and testing labs.

Civil engineers may also work in remote areas of foreign countries, often moving from place to place to work on different projects.

Civil engineers may be required to furnish part of their drafting equipment.

Civil engineers may belong to an association such as American Society of Civil Engineers. Members usually pay dues.

Tools, Equipment and Materials used may include:

- Drafting Tools and Equipment
- Blueprints and Specifications
- Handbooks

- Surveying Equipment
- Calculators
- Computers

Worker Requirements

You should like:

- Working with scientific and technical subjects
- Work requiring precise results
- Performing a variety of duties

You should be able to:

- Supervise others
- Accept responsibility
- Perform mathematical operations quickly and accurately
- Perform detailed and accurate work
- Make judgments based on verifiable information
- Express yourself clearly, both verbally and in writing

Physically you must:

- See well, either naturally or with correction
- Have full use of arms, legs and hands

Special Requirements:

All fifty states and the District of Columbia have licensing regulations for engineers whose work affects life, health, or

OCCUPATION SPECIALTIES

DOT CODE:

005.061-014 Civil Engineer
005.061-038 Transportation Engineer
005.061-034 Structural Engineer

005.061-018 Hydraulic Engineer
005.061-030 Sanitary Engineer
005.061-014 Environmental Engineer

SOC CODE: 1628



STRUCTURAL ENGINEERING CAREER SEARCH ABSTRACTS

DAY 8 ACTIVITIES



CIVIL ENGINEER

property. Each state administers its own examination. All states now have legal provisions to grant engineering licensing by reciprocity.

Opportunities for Experience

Part-time employment may be available as an engineering assistant after one or two years of college. Co-op programs in college and summer employment on construction sites provide experience.

Methods of Entry

Methods of entering this occupation include direct application to employers and taking civil service exams. Positions may also be located by consulting local newspaper want ads, college placement offices and the state employment office.

Earnings and Advancement

Earnings depend upon the size of the employer, geographic location and employee's qualifications.

Earnings

A civil engineer with a bachelor's degree earned an average starting salary of \$27,817 in 1990. All civil engineers earned an average salary of \$766 per week or \$39,844 per year. A civil engineer employed by the Federal Government earned an average of \$45,971 in 1990.

Fringe Benefits

Depending on the employer, civil engineers may receive paid vacations and holidays; paid sick leave; life, accident, disability and hospitalization insurance; and retirement plans. These benefits are usually paid for, at least in part, by the employer. Civil engineers may also receive educational reimbursements, a company car, and an expense account.

Career Ladder for this Occupation may look like this:

- Researcher

- Supervisor
- Civil Engineer

Civil engineers may advance with experience or additional training or education.

Employment and Outlook

There were approximately 186,000 civil engineers employed nationally in 1988. A growing economy is expected to increase demands for manufacturing plants, transportation systems, generating plants, off-shore drilling facilities, and environmental pollution control.

Civil engineers held about 1,378 jobs in Oklahoma during 1986. That number is expected to increase to 1,448 by 1992 which represents a 5.07 percent change. Job openings each year for civil engineers will equal approximately 46, with 34 of those due to replacements and 12 created through new jobs.

Related Education and Training

Level(s) of education and training usually needed for this occupation:

- College bachelor's degree
- College master's degree

Level(s) of education and training also available for this occupation:

- Technical junior or community college

School subjects helpful in preparing for this occupation include:

- College Preparatory
- Algebra
- Computer Science
- Trigonometry
- Chemistry
- Economics
- Drafting
- Composition
- Calculus
- Geometry
- Biology
- Physics
- Blueprint Reading
- Mechanical Drawing

More Sources of Information

- American Society of Civil Engineers
345 East 47th Street
New York, NY 10017
- JETS-Guidance
1420 King Street, Suite 405
Alexandria, VA 22314-2715
- Accreditation Board for Engineering and Technology
345 East 47th Street
New York, NY 10017
- State Civil Service Commission



CONSTRUCTION & BUILDING INSPECTOR



Nature of the Occupation

Construction inspectors, employed by government agencies, examine public and private construction projects to ensure that set standards of safe construction and quality of work are observed.

Duties may include but are not limited to the following:

- Inspecting buildings during and after construction
- Explaining regulations and codes to builders and property owners and recommending changes in procedures
- Inspecting wiring, fixtures, and equipment for safety
- Inspecting plumbing and sewer systems, fire sprinkler systems, and air and gas piping systems
- Inspecting building sites for soil type to determine fill and seepage conditions
- Interpreting blueprints and specifications
- Verifying levels, alignment, and elevation of installations

Occupation Specialties

(Dot codes in parenthesis)

Building Inspectors (168.167-030) make on-site inspections of new and existing buildings to

enforce conformance to state and city building codes, zoning laws, and approved standards.

Electrical Inspectors (168.167-034) check electrical installations for conformance to safety laws and ordinances.

Plumbing Inspectors (168.167-050) check plumbing installations for conformance to governmental codes, sanitation standards, and construction specifications.

Construction Inspectors (182.267-010) employed in the construction industry, examine and oversee the construction of bridges, dams, highways, and other types of construction work to ensure that procedures and materials comply with specifications.

Elevator Inspectors (168.167-038) examine the safety of lifting and conveying devices such as elevators, escalators and ski lifts.

Mechanical Inspectors (168.167-046) examine the installation of kitchen appliances, heating and air conditioning equipment and gasoline tanks to ensure that they comply with safety standards.

Working Conditions

Construction inspectors work under general supervision. They work closely with construction superintendents, engineers, and skilled craft workers.

Construction inspectors spend about half their time in an office reviewing blueprints, writing reports, and scheduling inspections. The rest of their time is spent traveling to construction sites.

Inspection sites may be dirty and cluttered. Inspectors may have to climb ladders or several flights of stairs, or crawl beneath buildings. However, the work is not considered hazardous.

The average work week is normally 40 hours. However, after an accident at a construction site inspectors must respond immediately and may work irregular hours to complete their report. Inspection work tends to be steady, year round. Inspectors may spend a large portion of their time traveling and they may be required to provide their own cars.

Tools, Equipment and Materials used may include:

- Federal, State & City Statute Books
- Blueprints & Charts
- Reference Books
- Surveyor's Level & Transit
- Measuring Instruments
- Voltmeters
- Ammeters

Worker Requirements

You should like:

- Activities of a scientific, technical nature

OCCUPATION SPECIALTIES

DOT CODE

168.167-030 Inspector, Building

168.167-034 Inspector, Electrical

168.167-050 Inspector, Plumbing

SOC CODE: 1472

182.267-010 Construction Inspector

168.167-038 Elevator Inspector

168.167-046 Mechanical Inspector

OKLAHOMA
**CAREER
SEARCH**



CONSTRUCTION & BUILDING INSPECTOR

You should be able to:

- Communicate and work well with people at all levels
- Use math accurately
- Picture three-dimensional objects from drawings and diagrams
- Keep detailed records

Physically you must:

- Maintain good vision and hearing, either naturally or with correction
- Reach, handle, and finger objects
- Stand and walk for long periods
- Climb and maintain your balance while inspecting buildings

Special Requirements:

To become an inspector, several years of experience as a construction contractor, supervisor, or skilled worker is generally required. Inspectors must also have valid drivers' licenses.

Opportunities for Experience:

Individuals wishing to explore the occupation may work as helpers to skilled craft workers. Part-time work may be available in small communities.

Methods of Entry:

Apply directly to federal, state, and local civil service offices. Jobs may be located by consulting college placement offices, newspaper want ads, and trade publications.

Earnings and Advancement

Earnings of inspectors depend upon job specialty, geographic location, and amount and nature of an individual's work experience. Salaries are usually set by local governments according to civil service regulations.

Earnings:

Nationally, in 1990, experienced inspectors earned an average weekly salary of \$590, for an annual salary of \$29,499. Inspectors employed by the Federal Government earned an

average income of \$29,343 in 1990.

Fringe Benefits:

Fringe benefits received by inspectors may include paid holidays and vacations; sick leave; health, life, and disability insurance; and a company car. These benefits are usually paid for, at least in part, by the employer.

Career Ladder for this Occupation may look like this:

- Supervisor
- Chief Building Inspector
- Building Inspector
- Skilled Craft Worker
- Trainee

An engineering degree is often needed in order to advance to supervisory inspector.

Advancement in government agencies is usually through competitive examination.

Employment and Outlook

There were approximately 56,000 construction and building inspectors employed nationally in 1988. Employment is expected to grow as fast as the average for all occupations through the year 2000. Increases in construction activity and concern for public safety should spur the demand for these occupations. Engineers, maintenance supervisors, and construction managers are able to fulfill many of the duties of a construction inspector, thereby limiting job opportunities. Best prospects are available for highly experienced craft workers who have some college training or who are certified.

Construction and building inspectors held about 622 jobs in Oklahoma during 1986. That number is expected to increase to 640 by 1992 which represents a 3.22 percent change. Job openings each year for construction and building inspectors will equal approximately 59, with 56 of those due to

replacements and 3 created through new jobs.

Related Education and Training

Level(s) of education and training usually needed for this occupation:

- On-the-job training
- Technical junior or community college

Level(s) of education and training also available for this occupation:

- College bachelor's degree

School subjects helpful in preparing for this occupation include:

- Blueprint Reading
- Drafting
- Wood Shop
- Building Trades & Carpentry
- Shop Math

More Sources of Information

- International Conference of Building Officials
5360 S. Workman Mill Road
Whittier, CA 90601
- International Association of Electrical Inspectors
930 Busse Highway
Park Ridge, IL 60068
- National Conference of States on Building Codes and Standards
505 Huntmar Drive, Suite 210
Herndon, VA 22070
- International City Management Association
1120 G Street, NW, Suite 300
Washington, DC 20005
- Home Builders Institute
15th and M Streets
Washington, DC 20005
- State, County, and City Civil Offices



CONSTRUCTION LABORER



Nature of the Occupation

Construction laborers assist skilled workers by unloading materials, machinery and equipment; lifting and carrying materials and tools; mixing or preparing materials, and preparing and cleaning work areas.

Duties may include but are not limited to the following:

- Hauling and hoisting materials
- Digging ditches and excavations for foundations
- Driving stakes
- Mixing, pouring, and spreading concrete, asphalt, or gravel
- Erecting and dismantling scaffolds
- Laying sewer and water pipes
- Grinding, sanding, and polishing surfaces
- Helping to raze buildings and salvage useful materials
- Loading and unloading trucks

- Cleaning tools and equipment
- Cleaning the construction site

Occupation Specialties

(Dot codes in parenthesis)

Hod Carriers or Masons' Helpers (869 687-026) work as bricklayers' or plasterers' helpers by supplying materials, setting up and taking down scaffolds, and performing other services.

Working Conditions

Construction laborers work under the supervision of a construction supervisor or skilled worker. They work outside most of the time and are exposed to cold, heat, and inclement weather. Some work may be hazardous. Construction laborers may climb ladders or work on scaffolds and work in noisy, dirty or bad smelling areas.

Construction laborers may work on a day-to-day basis. The work

generally picks up during the summer months when weather conditions are more favorable.

Construction laborers normally work a 5-day, 40-hour week. They may frequently be required to work overtime in order to complete a project by a specific date.

Construction workers may be required to buy and wear protective clothing such as hard-toed shoes, protective glasses, and hard hats. They may also have to furnish their own hand tools.

Construction laborers may belong to unions. About three-fourths of construction laborers belong to a union. The particular union depends on the place of employment and the type of work performed. Members usually pay dues.

Tools, Equipment and Materials used may include:

- Bale Hooks
- Crowbars
- Forks
- Mixing Machines
- Cutting Torches
- Air Tools
- Concrete Vibrators
- Tamping Tools
- Scaffolds
- Hods
- Shovels, Spades & Rakes
- Handtrucks, Carts & Dump Buggies
- Power Buggies
- Concrete Saws

Worker Requirements

You should like:

- Doing routine work
- Working with tools and machines
- Working with your hands
- Working outdoors
- Working with your hands

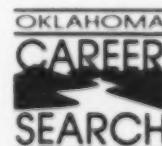
OCCUPATION SPECIALTIES

DOT CODE:

869 687-026 Construction Worker

869 687-026 Hod Carrier

SOC CODE: 871



STRUCTURAL ENGINEERING CAREER SEARCH ABSTRACTS

DAY 8 ACTIVITIES



CONSTRUCTION LABORER

You should be able to:

- Follow specific directions
- Perform a variety of duties which may change often
- Work within set standards of accuracy

Physically you must:

- Stand or walk for long periods
- Reach for and handle objects
- Lift and carry materials weighing 50 pounds or more
- Climb up and down ladders carrying tools and equipment

Opportunities for Experience

Summer or part-time employment with construction companies may provide experience. All branches of the military service offer opportunities for experience.

Methods of Entry:

Methods of entering this occupation include direct application to employers and local unions. Positions may also be located by consulting newspaper wants ads and the state employment office.

Earnings and Advancement

Earnings depend upon the employer, location, type of work performed and unionization.

Earnings:

Nationally, in 1990, the median earnings for handlers, helpers, and laborers were about \$300 per week. The middle 50 percent earned from about \$218 to \$435 per week. The top 10 percent earned about \$555 weekly. The bottom 10 percent earned about \$169 weekly.

Construction laborers have higher weekly earnings than other workers in this group. Bad weather and slower times in the construction industry can cause construction workers to lose work time.

Fringe Benefits:

Depending on the employer, construction laborers may receive

vacation pay, life, accident, disability and hospitalization insurance, and retirement plans. These benefits are usually paid for, at least in part, by the employer. In some cases, employers and employees may jointly contribute to union funds used to pay certain benefits.

Career Ladder for this Occupation may look like this:

- Skilled Trade Worker
- Skilled Trade Apprentice
- Construction Laborer

Advancement for construction laborers usually consists of moving to higher level positions after some training and/or experience.

However, a construction laborer may become a skilled trade worker after several years of experience and training or by completing an apprenticeship program.

Employment and Outlook

There were approximately 555,000 construction laborers employed nationally in 1988. Employment of construction laborers is expected to grow slower than the average for all occupations through the year 2000. Job openings should be plentiful because turnover is high. Employment of construction laborers is highly sensitive to cyclical swings in the economy, particularly the level of construction activity. Consequently, layoffs are common among these workers when the level falls.

Construction laborers held about 973 jobs in Oklahoma during 1986. That number is expected to increase to 1,038 by 1992 which represents a 4.84 percent change. Job openings each year for construction laborers will equal approximately 32, with 21 of those due to replacements and 11 created through new jobs.

Related Education and Training

Level(s) of education and training usually needed for this occupation:

- Less than a high school diploma

Level(s) of education and training also available for this occupation:

- On-the-job training

School subjects helpful in preparing for this occupation include:

- Building Trades & Carpentry
- Shop Math
- Industrial Arts
- Woodshop

More Sources of Information

- Laborers' International Union of North America
905 16th Street, NW
Washington, DC 20006
- National Association of Home Builders of the U.S.
15th & M Street, NW
Washington, DC 20005
- Associated General Contractors of America
1957 E Street, NW
Washington, DC 20006
- Construction Industry Management Board
1101 15th Street, NW
Suite 1040
Washington, DC 20006

STRUCTURAL ENGINEERING CAREER SEARCH ABSTRACTS

DAY 8 ACTIVITIES



COST ESTIMATOR, CONSTRUCTION



Nature of the Occupation

Construction cost estimators prepare cost estimates and analyze data for construction projects or aid management in bidding on or determining the cost of construction materials or services. Data compiled and analyzed include that on materials, labor, location, and machinery.

Duties may include but are not limited to the following:

- Compile lists of the type of materials, tools, fixtures, or equipment required
- Gather information on access to site, and availability of electricity, water, and other services
- List by item the tools, fixtures, or equipment to be manufactured by the company or purchased from outside sources
- Compute cost estimates for materials, purchased equipment, subcontracted work, production activities and requirements, and labor
- Conduct special studies to reduce costs or to develop and establish standard hour and related cost data
- Consult with personnel or other departments relating to cost problems

Occupation Specialties

(Dot codes in parenthesis)

Contractors (182.167-010) perform specified construction work according to architects' plans, blueprints, codes, and specifications, including estimation of costs of material, labor, and equipment.

Material Listers (229.387-010) review blueprint and material specifications to determine amount, size, kind, grade, and place of delivery of materials for building construction projects.

Assistant Construction Superintendents (869.367-010) assist superiors in directing activities of workers on construction projects and in planning construction procedures, specifications, work schedules, and material needs.

Working Conditions

Although construction cost estimators spend most of their time in clean, comfortable, well-lighted, and well-ventilated offices, they must frequently visit construction sites that are dirty and cluttered. They work under the pressure of deadlines and the need for accuracy. Their normal work week is 40 hours, with work performed during regular business hours, 8:00 a.m. to 5:00 p.m. Overtime may sometimes be necessary to meet deadlines. Travel from one site to

another is usually reimbursed in part or in full.

Tools, Equipment and Materials used may include:

- Computers
- Catalogs
- Rate and Record Books
- Technical Tables
- Calculators and Adding Machines
- Diagrams, Blueprints, Charts, and Manufacturing Specifications

Worker Requirements

You should like:

- Activities of a scientific and technical nature
- Activities which involve the use of machines and processes
- Activities dealing with things and objects

You should be able to:

- Use reason and logic
- Communicate well in speech and writing
- Use mathematics quickly and accurately to determine costs
- Visualize flat drawings or pictures as solid objects
- See detail in objects or drawings and recognize slight differences in shapes or shadings
- Rate information using personal judgment
- Perform work accurately
- Rate information using measurable, verifiable standards
- See details and recognize errors in numbers, spelling, and punctuation in written materials, charts, or tables

Physically you must:

- Speak and hear well, either naturally or with correction

OCCUPATION SPECIALTIES

DOT CODE

160.267-018 Estimator

182.167-010 Contractor

229.387-010 Material Lister

869.367-010 Assistant Construction Superintendents

SOC CODE 149, 133





COST ESTIMATOR, CONSTRUCTION

- See well, either naturally or with correction

Special Requirements:

Most construction cost estimators have experience as construction craftworkers or contractors. Those with experience and some postsecondary training in construction estimating or a bachelor's or associate's degree in civil engineering or building construction are more likely to find jobs than those with experience or education only. Beginning positions in the Federal Government require a bachelor's degree with a major in engineering, mathematics, business administration, or a related subject.

Opportunities for Experience:

Secondary vocational education programs in accounting and computing may offer a co-op portion through which experience may be gained. This occupation may also be explored by obtaining related employment in construction firms.

Methods of Entry:

Methods of entering this occupation include direct application to employers and promotion from entry-level jobs within construction firms. Assistance in locating a job may be obtained by consulting newspaper want ads.

Earnings and Advancement

The earnings of estimators may vary according to education, experience, amount of responsibility, geographic location, size and type of employer, and whether they are paid a commission on sales, as in some construction companies.

Earnings:

Nationally, in 1990, the average starting salary for people with limited training ranged from \$15,215 to \$19,562. College graduates with majors in fields

such as engineering or construction can start at \$32,588 or higher. Highly experienced individuals earned \$81,500 or more. Salaries in the manufacturing sector are somewhat higher than in other areas. The average starting salaries for cost estimators working for the Federal Government in 1990 were between \$16,367 and \$24,811.

Fringe Benefits:

Depending on the employer, most estimators receive paid vacations and holidays; life, accident, and hospitalization insurance; retirement plans; and sick pay. These benefits are usually paid for, at least in part, by employers. Some estimators also have a savings and stock investment plan. Some also receive cost-of-living allowances.

Career Ladder for this Occupation may look like this:

- Own Business
- Chief Cost Estimator
- Cost Estimator
- Qualified Craftworker or Contractor

Advancement for estimators is based on experience and the availability of job openings. Many estimators must have some experience in the industry in which they will work. They generally learn the technical knowledge needed to figure out costs accurately while working in other jobs.

Employment and Outlook

There were approximately 169,000 estimators employed nationally in 1988. Employment is expected to increase as fast as the average for all occupations through the year 2000. Most openings will occur as estimators leave the work force or transfer to other occupations. The level of employment will depend upon construction activity. Residential construction is expected to decline,

but an increase is expected in the demand for multiunit housing, commercial and industrial buildings, and health-related facilities. Other areas of expansion include maintenance and repair, commercial and industrial renovation, and hazardous waste. In the manufacturing sector, job opportunities for estimators will increase as more firms realize the importance of accurate estimating. Not only will estimators work on new projects, but they will monitor operations to uncover hidden costs or inefficiencies.

Cost estimators held about 1,168 jobs in Oklahoma during 1986. That number is expected to increase to 1,350 by 1992 which represents a 15.38 percent change. Job openings each year for cost estimators will equal approximately 73, with 43 of those due to replacements and 30 created through new jobs.

Related Education and Training

Level(s) of education and training usually needed for this occupation:

- On-the-job training
- Technical junior or community college
- College bachelor's degree

School subjects helpful in preparing for this occupation include:

- College Preparatory
- Building Trades & Carpentry

More Sources of Information

- National Estimating Society
101 South Whiting Street
Suite 313
Alexandria, VA 22304
- American Society of Professional Estimators, Inc.
6911 Richmond Highway
Suite 230
Alexandria, VA 22306



INDUSTRIAL ENGINEER



Nature of the Occupation

Industrial engineers design, improve, and install combined systems of machines, equipment, energy, and workers for maximum productivity.

Duties may include but are not limited to the following:

- Studying data to determine the functions and responsibilities of workers and work units
- Establishing work measurement programs and making observations to determine the best use of equipment and workers
- Developing programs to simplify work flow, work count, economy of worker motions, and layout of units
- Planning and overseeing plant safety and accident prevention programs
- Planning and overseeing job study and training programs
- Training industrial engineering technicians and other personnel

Occupation Specialties

(Dot codes in parenthesis)

Time-Study Engineers

(012 167-070) develop work measurement procedures and direct time-and-motion and incentive studies to promote the efficient use of employees and facilities. They may also develop recommendations affecting work methods and budget decisions.

Safety Engineers (012 061-014) examine plans and specifications of new machinery and inspect existing machinery and work areas to insure safety standards are being met.

Manufacturing Engineers

(012 167-042) determine space requirements, plan or improve production methods, estimate production times and the best use of personnel for production schedules, and direct and coordinate manufacturing processes in industrial plants.

Quality-Control Engineers

(012 167-054) plan and direct the development, application, and maintenance of quality standards for processing materials into partially-finished or finished products.

Working Conditions

Industrial engineers usually work with others as part of a team. They may also supervise other engineers or technicians. Industrial engineers may work in well-lighted and air-conditioned offices or in production areas where they may be exposed to fumes, noise, extreme temperatures, dust, and other plant conditions.

Industrial engineers usually work a 5-day, 40-hour week. Overtime may be required to complete a particular job. Industrial engineers employed by

consulting firms may travel extensively.

Industrial engineers may join professional organizations such as the Institute of Industrial Engineers. Members usually pay periodic dues.

Tools, Equipment and Materials used may include:

- Blueprints
- Specifications
- Charts
- Drafting Tools
- Stopwatches
- Plans
- Handbooks
- Computers
- Measuring Devices

Worker Requirements

You should like:

- Activities of a scientific and technical nature
- Activities involving machines, techniques, and people
- Activities which require creativity

You should be able to:

- Work within precise limits or standards of accuracy
- Perform a variety of duties which change often
- Think logically
- Perform mathematical calculations quickly and accurately
- Present your ideas effectively in speech and writing
- Observe details in objects or drawings and recognize slight differences in shapes or shadings
- Visualize flat drawings or pictures as solid objects
- Direct and plan activities

Physically you must:

- See well, either naturally or with correction

OCCUPATION SPECIALTIES

DOT CODE

012 167-030 Industrial Engineer
012 167-070 Time-Study Engineer
012 061-014 Safety Engineer

012 167-042 Manufacturing Engineer
012 167-054 Quality-Control Engineer

SOC CODE: 1634

OKLAHOMA
**CAREER
SEARCH**

STRUCTURAL ENGINEERING CAREER SEARCH ABSTRACTS

DAY 8 ACTIVITIES



INDUSTRIAL ENGINEER

Special Requirements

All fifty states and the District of Columbia have licensing regulations for engineers whose work affects life, health, or property. Each state administers its own examination. All states now have legal provisions to grant engineering licensing by reciprocity.

Not all engineers need to be licensed. The exceptions are engineers working: (1) for the Federal Government, (2) in a manufacturing or interstate commerce corporation, (3) in a public service corporation, and (4) as subordinates to registered engineers. However, the trend is toward licensing for everyone.

Opportunities for Experience

Summer or part-time work with research laboratories, manufacturing plants, and construction projects offer opportunities for experience.

Methods of Entry

Methods of entering the occupation include applying directly to employers and taking civil service exams. Positions may also be located by consulting newspaper want ads, professional journals, and college placement offices.

Earnings and Advancement

Earnings depend upon the employer and employee's experience and education.

Earnings

Nationally, in 1990, industrial engineers graduating with a bachelor's degree earned a starting salary of \$32,004. Those with a master's degree earned a starting salary of \$37,603 in 1990. Average salaries for industrial engineers in 1990 were \$49,750. Industrial engineers working for the Federal Government earned average salaries of \$45,971.

Fringe Benefits

Depending on the employer, industrial engineers may receive

paid vacations and holidays; life and hospitalization insurance; retirement plans; and paid sick leave. Many employers will also pay expenses for additional education.

Career Ladder for this Occupation may look like this:

- Supervisor
- Industrial Engineer
- Trainee

Industrial engineers may advance through experience, supervisory ability, and additional education.

Employment and Outlook

There were an estimated 132,000 industrial engineers employed nationally in 1988. Employment of industrial engineers is expected to grow as fast as the average for all occupations through the year 2000 due to increasing industrial growth, increasing complexity of industrial operations, and greater emphasis on scientific management and safety engineering. Jobs will also be created as firms seek to reduce costs and increase productivity through scientific management and safety engineering.

Industrial engineers held about 893 jobs in Oklahoma during 1986. That number is expected to increase to 1042 by 1992, which represents a 16.20 percent change. Job openings each year for industrial engineers will equal approximately 44, with 19 of those due to replacements and 25 created through new jobs.

Related Education and Training

Level(s) of education and training usually needed for this occupation:

- College bachelor's degree
- College master's degree

Level(s) of education and training also available for this occupation:

- Technical junior or community college

- College Ph.D. or professional degree

School subjects helpful in preparing for this occupation include:

- College Preparatory
- Algebra
- Geometry
- Trigonometry
- English
- Calculus
- Statistics
- Chemistry
- Physics
- Blueprint Reading
- Machine Shop
- Shop Mechanics
- Composition
- Physical Science
- Humanities
- Drafting
- Mechanical Drawing

More Sources of Information

- American Society of Safety Engineers
1800 East Oakton
Des Plaines, IL 60018
- American Society for Quality Control
310 West Wisconsin Avenue
Milwaukee, WI 53203
- Institute of Industrial Engineers
25 Technology Park Atlanta
Nocross, GA 30092
- Society of Women Engineers
345 East 47th Street
Room 305
New York, NY 10017

TECHNOLOGY EDUCATION STRUCTURAL ENGINEERING

DAY 8 ACTIVITIES



You will need a computer scan sheet or card to record your answers to the following Posttest. Be sure to write your name, the title of the TLA, the date, and the class period on the computer scan sheet or card using a #2 pencil. Use rows 26-35 to record the answers to the Posttest. If your answers will be hand-scored, use a blank sheet of notebook paper to record your answers and number your answers 26-35.

Use rows 36-40 on the test card. If the word is spelled correctly, mark (a) on the computer score sheet or card. If the word is spelled incorrectly, mark (b) on the test card. Be sure to use a #2 pencil and make your marks dark. If your answers will be hand-scored, use a blank sheet of notebook paper to record your answers and number your answers 36-40.

Get Posttest Questions from your instructor.

If you complete Day 8 Activities with time left over, you may complete a Problem Solving Activity from the Skunk Works.

POSTTEST

DIRECTIONS



SPELLING TEST DIRECTIONS

TECHNOLOGY EDUCATION STRUCTURAL ENGINEERING

SKUNK WORKS



The term *Skunk Works* comes from an engineering division of the 3M Company. In the late 1960s a group of engineers at 3M wanted to design a new product but the managers of the company would not give them the money for research. So they decided to design the product anyway, then try to convince the company to market it. Whenever the engineers could grab a few extra minutes from their assignments, they worked on the new product. In early 1969 they presented it to the marketing division of 3M, and the company has been selling it ever since. The product: Velcro fasteners.

As you read earlier, the first bridges were made where the bridge was needed. You have already designed a bridge that would use "modern" materials, since a truss bridge would have been constructed of steel. Now try designing a bridge using natural materials that might be found around you as you hike.

You have been hiking in the jungle when a sudden rainstorm hits, washing away a bridge between you and base camp. The materials available are vines, rocks, and dead trees. Design a bridge using these materials.

BACKGROUND

INTRODUCTION

SKUNK WORKS CHALLENGE

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